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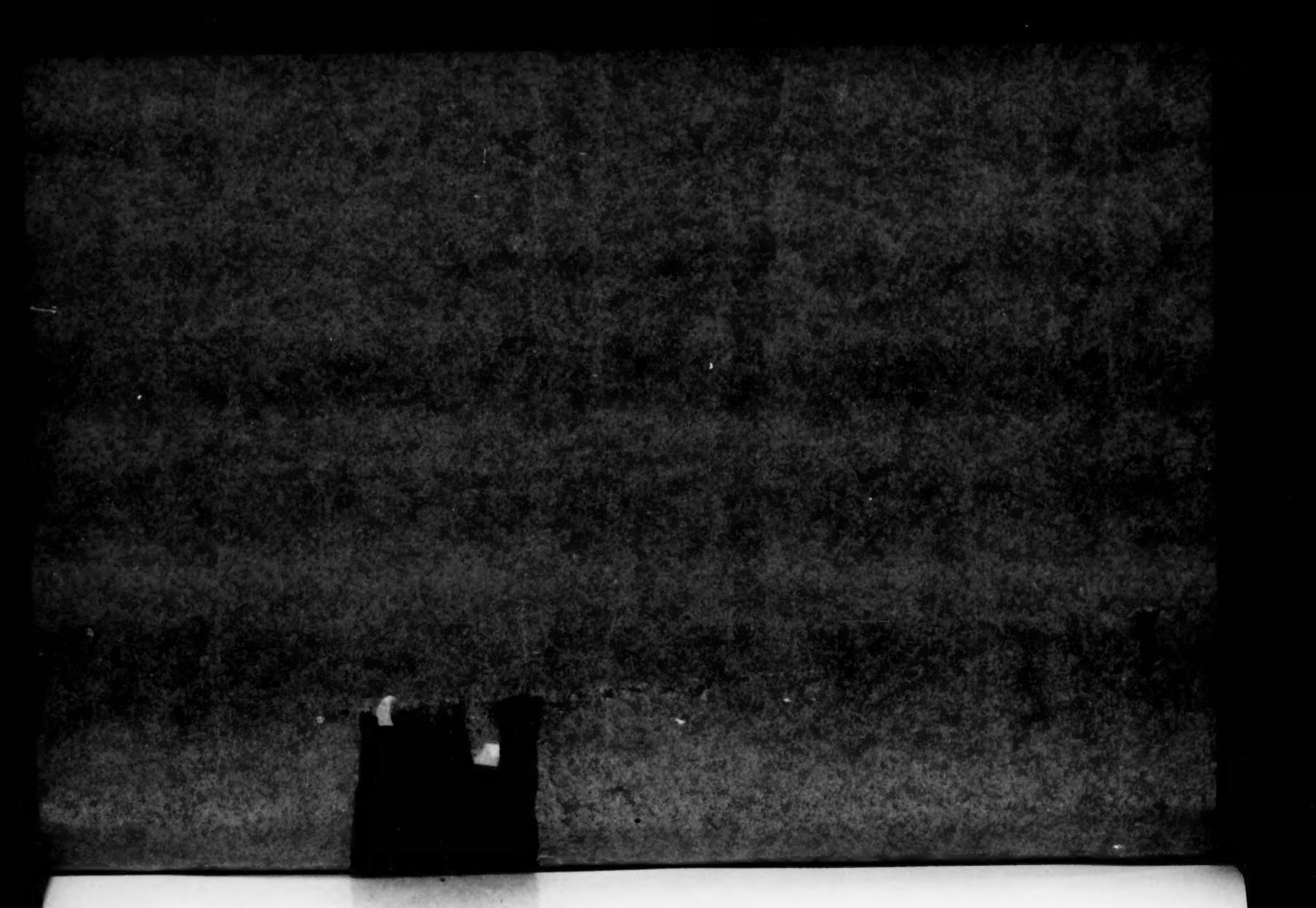

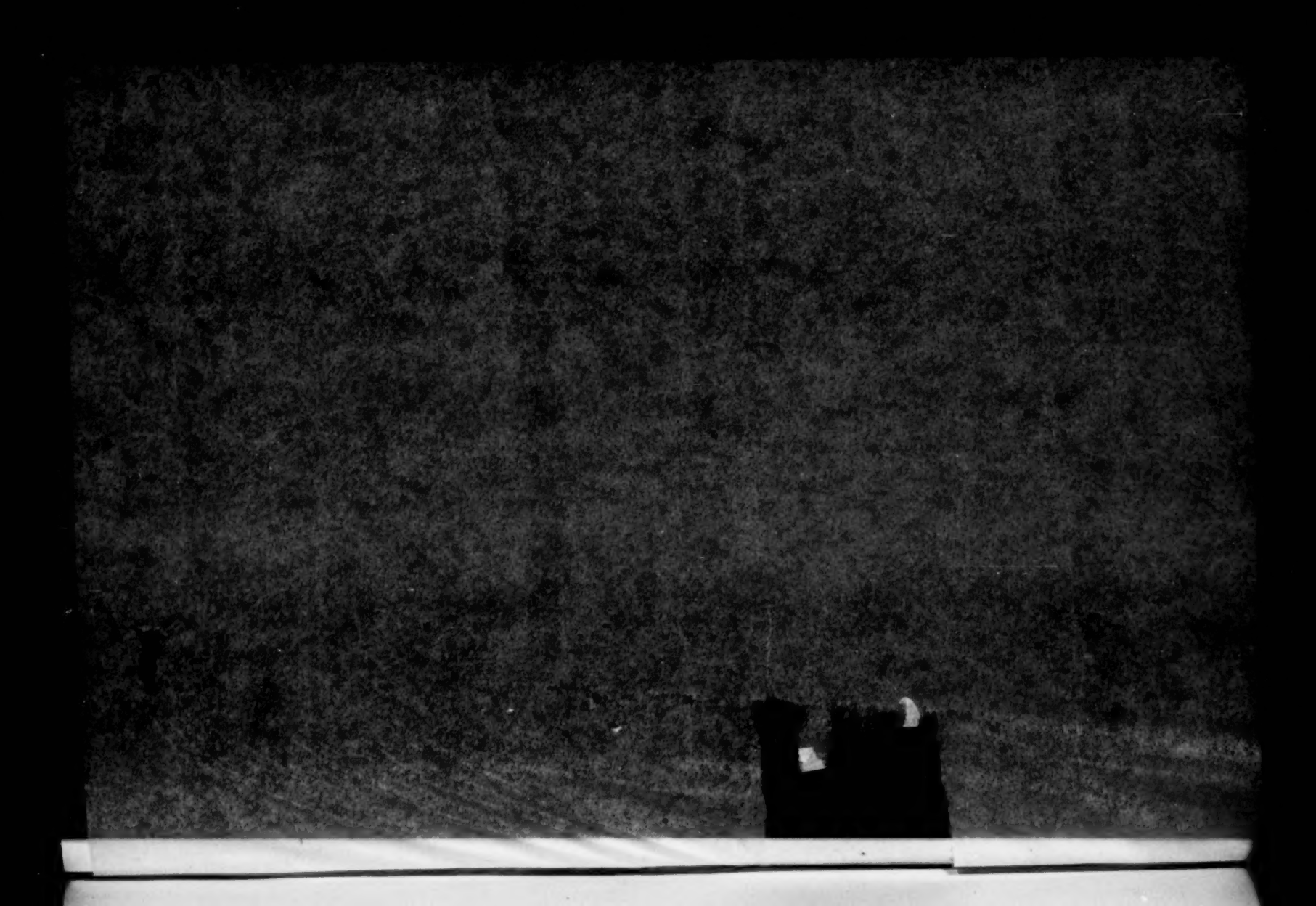

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## *ALFRED MARSHALL MAYER.*

A MAN of science, whose work was unique in the domain which he had selected, and who will long be held in warm remembrance by a large circle of friends, has lately passed away.

In 1784 there emigrated to America a young German, Christian Mayer, a member of an ancient family in the city of Ulm, in Würtemberg. He made his home in Baltimore, where, by strong intelligence and well directed industry, he amassed a fortune. To his two sons, Charles F. and Brantz, he gave the best educational advantages of the day. The former became a prominent lawyer, well known in the best social circles of Baltimore on account of his refinement and broad literary culture, while the latter traveled and wrote extensively, his historical work, especially in connection with Mexico, being of high authority and acknowledged value.

On the thirteenth day of November, 1836, a son was born to Charles F. Mayer. At an early age the boy exhibited great mechanical ingenuity and a lively interest in the external world of nature. At St. Mary's College, in Baltimore, he was afforded all the usual facilities for an elementary liberal education, and especially for classical training; but this did not suit his native bent. At the age of sixteen years he gave up the school room, and the following two years were spent chiefly in the workshop and the draughting room of a mechanical engineer. Here was abundant opportunity for acquiring familiarity with the use of tools and developing manipulative skill. At the same time there was a continual stimulus to private study in connection with the daily application of the laws of physics and mechanics. This course of study in applied science was a natural precursor to the resumption of more systematic work, not in the class room, but in the laboratory. A course of

chemistry was undertaken, and two years were spent largely in mastering the principles and processes of quantitative analysis.

It was during these years of private study and practical work that young Mayer attracted the attention of a man whose personal influence was chiefly instrumental in determining the future direction of the student's energies. Joseph Henry was at this time Secretary of the Smithsonian Institution, and for thirty years he had been identified with the advancement of pure science in America. Industrial science needs no advocates. Its importance is recognized by all. Its immediate connection with material progress and its quick response to commercial demands are sufficient to bring within the ranks of its devotees the great majority of those who undertake laboratory work with a definite purpose. Henry had never underrated the value or the need of industrial science, but he had emphasized the importance of investigation from the more unselfish standpoint of one who regarded intellectual acquisition as a priceless good in itself apart from all commercial recompense. He apprehended the brightness, the alertness, the originality of the Baltimore student, and accorded him that sympathetic recognition which constitutes the greatest stimulus that a young man can receive. The friendship of an acknowledged master makes a willing and easily directed pupil. Ideals of excellence are thus formed for life. Subsequent experience may sometimes modify these, but they are rarely ever discarded.

At the early age of twenty years Mayer was appointed to the chair of physics and chemistry in the University of Maryland. He had already during the previous year published his first contribution to science, the description of a 'new apparatus for the determination of carbonic acid.' This was soon republished in Germany. His new duties absorbed now most of his time, but a second paper appeared in the *American Journal of Science*, in 1857, on the estimation of the weights of very small portions of matter. In this he showed that by the deflection of a fine glass fibre it is possible to estimate a variation in weight so small as the thousandth part of a milligram. In 1859 he accepted a chair in Westminster College, Missouri, where two years were spent; but the equipment of this institution was insignificant and no original work was accomplished. The breaking out of the Civil War determined his return to Baltimore, and in 1863 he went to Paris, where two years were occupied in special study, chiefly under the direction of Regnault. The influence of the great French physicist, and the general atmosphere of the University of Paris, strengthened the bias in favor of pure science which had been received in youth from Henry.

Soon after his return to America, in 1865, Professor Mayer was called to the chair of physics and chemistry at Pennsylvania College, in Gettysburg, which he gave up, in 1867, to accept that of physics and astronomy in Lehigh University. This in turn was renounced in 1871 for the purpose of joining in the upbuilding of the new Stevens Institute of Technology, at Hoboken, with which his connection continued up to the time of his death, July 13, 1897. It is with this institution, therefore, that his name will always be chiefly identified, though his researches were for the most part in channels somewhat removed from those that are usually characteristic of an engineering school. Its instrumental equipment was unusually good, and proximity to a great metropolis afforded the intellectual stimulus and the prompt recognition of merit which are wanting in isolated institutions of learning.

While connected with Lehigh University,

Professor Mayer designed an astronomical observatory and superintended its construction. He erected the instruments and, without assistance, finished the tedious work of adjusting them. A series of observations on Jupiter followed, and its publication was reproduced in England. During the summer vacation of 1869 he was deputed by the United States government to take charge of a party of astronomers at Burlington, Iowa, where the solar eclipse of August 7th was observed. During the eclipse more than forty successful photographs were taken, each exposure lasting 0.002 second. Four of these were during the eighty-three seconds of totality. This was in the early days of instantaneous photography and was accounted an unusual feat. An abstract of the results of measurements on these photographs was published in the Journal of the Franklin Institute. In the same journal, about this time, he published a number of articles on physical and astrophysical subjects. At the Salem meeting of the Scientific Association, 1869, a paper was read 'On the thermodynamics of waterfalls.' At Trenton Falls and at Niagara Falls careful observations had been made on the temperature of the water at the top of the cataract and just beyond the point of impact at the bottom. The arrest of motion develops heat, and this was found to be manifested in a measurable rise of temperature, when the air was charged with moisture and not much warmer or colder than the water, the change being in accordance with calculation based on Joule's equivalent. But under other conditions this effect was masked to such an extent by the cooling effect of evaporation and conduction that there was sometimes a lower temperature at the bottom than at the top.

Soon after entering upon his duties at Hoboken, Professor Mayer began the series of investigations in acoustics for which he is perhaps best known, and which made him decidedly the leading authority on this subject in America. In the first of his papers he showed how the co-vibration of two nearly unisonant tuning forks may be utilized to demonstrate Doppler's well-known principle that wave-length may be modified by translation of the vibrating body. This was soon followed by another paper in which he gave a method of detecting the phases of vibration in the air surrounding a sounding body. Two resonators responding to the pitch of the source were employed, each connected with a manometric capsule. One of these resonators being fixed and the other movable, the recurring changes in the compound flame image gave the means of measuring wave-lengths directly in the vibrating air and exploring the form of the wave surface. A simple and precise method was developed from this for measuring wave-lengths and velocities of sound in gases at various temperatures; and an acoustic pyrometer was devised by which furnace temperatures were capable of measurement with a degree of accuracy approaching that of the air thermometer. The same optical method of interference was then further applied to the determination of the relative intensities of sounds. The range of application of this method is somewhat limited, but within this range it is more precise than any other method devised for the same purpose. One application was to the measurement of the powers of various substances to transmit and to reflect sonorous vibrations. An investigation of the relative absorbing powers of different media for sound led to an approximate determination of the mechanical equivalent of an aërial sonorous vibration. The energy per second given forth in aërial vibrations by an $Ut_3$ fork (256 vd.), set in motion by intermittent electro-magnetic action and placed before an appropriate resonator, was

found to be about one millionth of Joule's unit, or enough to raise one gram through a height of ten centimeters. This result was accomplished by measuring the relative intensities of the sound given forth by the same fork, first when vibrating freely, then when the motion of its prongs was damped by the expenditure of part of its energy on india rubber. The rise of temperature of the rubber was measured by use of thermopile and galvanometer, and its specific heat determined by ordinary methods. The difficulties attendant upon such an experiment are very great, and no one but an experimentalist of exceptional skill and patience would be apt to undertake it.

These strictly physical investigations led Professor Mayer into the domain of physiology in its bearing upon the phenomena of audition. The most important principle in acoustics is that of harmonic motion, simple and compound, as embodied in Fourier's theorem. Helmholtz was the first to apply this to the analysis of musical quality, and in doing so the subjective method of resonators was utilized with great skill. Professor Mayer sought objective methods and devised several of these, the most striking of which was that of employing tense threads as media for the conveyance of energy from a vibrating membrane to mounted tuning forks adjusted in pitch to respond to the components of the compound sound under examination. Recognizing the capacity of the ear, when sufficiently trained, to accomplish this analysis to a considerable extent without instrumental aid, he sought to learn the mechanism of the auditory apparatus of some of the lower types of animal life. Some new and interesting facts were thus discovered in relation to the function of the antennæ of the mosquito in audition, and he showed how an insect may determine the direction of sounds by means of its antennæ. In this connection good reason was found for the belief that the terminal auditory nerve fibrils in the human ear vibrate just half as often in a given time as the membrane of the tympanum and the ossicles. This hypothesis partially accounts for the marked difference in quality when the same sound is successively heard, first directly through the open ear and then through the medium of the bony portions of the head.

Professor Mayer's most important acoustic research was his determination of the law connecting the pitch of a sound with the duration of the residual sensation in the ear. An explanation of the method adopted cannot be here given without entering unduly into details. This law gave a quantitative character to results which Helmholtz had attained only qualitatively. It is of fundamental importance in its application to musical harmony. It explains why certain combinations of tones which are harmonious in the upper portions of the musical scale become rough and discordant in the lower portions. This mere fact the musical composer was long compelled to recognize, though hitherto it had been inexplicable. The labor involved in this work was great, and before its completion the investigator's power of audition in one ear was thereby permanently impaired. The first experiments were published in 1874; a redetermination was made in 1875, and again with improved apparatus in 1893. He received the assistance of the most accomplished musical experts, including Madame Seiler, who had been associated with Helmholtz for a somewhat similar purpose, and Dr. Rudolph Koenig, of Paris, whose training in the detection of musical beats is unrivaled. Dr. Koenig, in 1893, rendered important service in ascertaining the limitations of what may now be properly called 'Mayer's Law.' This law is expressed by an equation in which the duration of the residual sensation is given as a function of vibration frequency, and

this equation is readily translated into a curve. Between the limits of 100 and 4,000 vibrations per second there is closer accordance between the results of calculation and observation than in the case of Fechner's law, or indeed any other physiological law for which the attempt has been made to express sensation mathematically. Between 200 and 2,000 vibrations, including the range most constantly resorted to in music, the accordance is satisfactory, even when measured by physical rather than physiological standards. Due recognition of these important contributions to acoustic theory have been made by Mr. Ellis in his translation of Helmholtz's 'Tonempfindungen,' and by Professor Zahm in his recent book (1892) on 'Sound and Music.' Mr. Ellis gave a special lecture in London for the purpose of explaining these discoveries and their application to the principles of musical harmony.

It was natural for Professor Mayer to apply acoustic methods in work primarily undertaken for other purposes. In 1876 he devised improvements in what is now generally known as the electrographic method for the measurement of the velocity of projectiles and the determination of pitch. He utilized the spark from an induction coil for the purpose of marking seconds upon the sinuous trace of a tuning fork on smoked paper, and attained results of great accuracy. He studied with care the laws of vibration of tuning forks, and was the first to give accurately the correction to be applied in all such determinations on account of variation in temperature of the fork. Between 1889 and 1894 he conducted an elaborate research on the variation of the modulus of elasticity of various materials with change of temperature, as indicated by the transverse vibration of bars. From the observed pitch the velocity of propagation of sound in the bar is found, and this gives the modulus of elasticity. For the accurate determination of pitch it was necessary to visit Paris, where access was had to Dr. Koenig's grand tonometer, and where this accomplished acoustician freely gave his time and skill in furtherance of the work. The remarkable regularity in the results shows that this acoustic method, as conducted, is worthy of the greatest reliance. Among the materials thus studied was aluminum. Its modulus was found to be subject to large variation, and in every respect it is far inferior to steel for acoustic purposes.

Among the acoustic discoveries of Professor Mayer may be mentioned his observation that the sensation of a sound may be obliterated by the simultaneous action on the ear of another sound of greater volume and lower pitch, but that the converse is not true. The higher pitch, even when intense, cannot obliterate the sensation of another sound of lower pitch. This does not imply that the higher pitch is thus always completely obliterated. Its presence modifies the compound perception after the possibility of singling it out has vanished. The apprehension of this truth caused him to suggest certain changes in the method of conducting orchestral music, but they were not adopted on account of counter-balancing inconveniences in practice.

In 1876 Professor Mayer discovered that the air pressure on the inner surface of the bottom of a resonator in action exceeds that on the corresponding outer surface. This led to the construction of the 'sound mill,' composed of pairs of resonators so balanced and pivoted on their supports as to be set into rotation by reaction on sounding near them a tuning fork to which they are adapted. This phenomenon of acoustic repulsion was shortly afterward discovered independently by Dvorâk in Austria. Another application of resonators by Professor Mayer was in the invention of the topophone, an instrument with which the direc-

tion of sound at sea, such as that of a fog horn, could be determined with a close approximation to accuracy. His last publication in acoustics was on the production of audible beat tones from two vibrating bodies whose frequencies are so high that the separate tones are inaudible. This paper was read at the Oxford meeting of the British Association in 1894. The existence of such beat tones has been doubted by some. In the present case I was associated with Professor Mayer during some of his experiments, and had previously had considerable experience in the use of the sources of sound which he employed. As to the reality of the results he claimed there cannot be the least doubt on the part of any person possessing ordinarily acute powers of hearing, who will take the trouble to repeat the experiments.

The study of the physiology of sensation tempts to the investigation of the problems of vision in connection with those of audition. During the winter and spring of 1893 Professor Mayer became much interested in the phenomena of simultaneous color contrast, of which it may yet be said that no satisfactory explanation is provided by any existing theory of color vision. It has been common to assume that the modification of color perception induced by contrast is due to unconscious motion of the observer's eyes, to error or fluctuation of judgment, or to incipient retinal fatigue. Professor Mayer devised a variety of methods of presenting these phenomena with unexampled vividness, and on so large a scale as to enable him to arrive at quantitative statements of such subjective color by comparison with standard hues with which they were matched on the revolving color disk. Vivid contrast hues were readily perceptible when the illumination was secured by means of a momentary electric flash, and with entire accordance between different observers who had been purposely misled to expect something different from what they actually perceived. The hypothesis of retinal fatigue, or fluctuation of judgment, or ocular motion, is excluded under such conditions. This psychological element of color contrast led to the development of a disk photometer for measurement of the brightness of colored surfaces. In the use of it a degree of accuracy was attained in excess of that usually found possible with the Bunsen photometer.

While still at the Lehigh University Professor Mayer began investigations on electricity, on magnetism and on heat, which were resumed from time to time during subsequent years in the intervals between his acoustic researches. His lecture notes on physics were published serially in the Journal of the Franklin Institute, and, subsequently, put into book form. He devised a zero-method of comparing the strengths of electro-magnets and electrical conductivities, made many observations on magnetic declination, and improved on previously known methods of fixing and photographing magnetic spectra. He undertook an elaborate research on the effect of magnetization in changing the dimensions of iron and steel bars, an effect discovered by Page in 1837, investigated by Joule in 1842, and then neglected for thirty years. It was about this time that an unusually large electro-magnet was constructed for the Stevens Institute of Technology, and was employed with much effect in public lectures. One of these, entitled 'The Earth a Great Magnet,' was given by invitation of the Yale Scientific Club and, subsequently, published. In connection with it a special form of lantern galvanometer was devised for vertical projection, which attracted much notice. Another lecture demonstration which a few years afterward attracted general attention was that of the configurations formed by magnets floating vertically and subjected to the attraction of a superposed magnet.

The multiple or oscillatory character of the electric discharge from a Leyden jar was discovered by Henry in 1842. It was carefully studied afterward by Feddersen, who used a revolving mirror, and yet more fully by Rood, who employed several methods, but more particularly that of the revolving disk with radial slits. Professor Mayer, in 1874, took advantage of centrifugal action to give steadiness to a disk of blackened paper rotated rapidly between the electrodes employed for transmission of the spark. The perforations were then subjected at leisure to micrometric measurement. Since the rotation of the disk is known, the means is thus afforded for measuring the duration of the discharge and the intervals between the successive sparks which compose it. The conditions were then studied for securing the most nearly simple discharge possible. This served as the necessary antecedent to the successful employment of the induction coil in conjunction with a method previously devised for measuring minute intervals of time with the tuning fork, or rating a tuning fork by comparison with a standard clock. The combination formed an admirable chronoscope for a variety of purposes, but more especially for measuring the velocity of projectiles.

On the general subject of heat Professor Mayer published several articles. The first of these, in relation to waterfalls, has been already mentioned. In 1872 he devised a method of tracing the progress and determining the boundary of a wave of conducted heat by taking advantage of the variation in color with change of temperature which is characteristic of certain double iodides. The same method was applied three years afterward to the securing of thermographs of the isothermal lines of the solar disk. In 1890 he gave publication to a paper on the determination of the coefficient of cubic expansion of a solid from the observation of the temperature at which water in a vessel made of this solid has the same apparent volume as it has at 0° C., and on the coefficient of cubic expansion of a substance determined by means of a hydrometer made of it. The method was applied to several different substances, including brass and vulcanite. This led to a general investigation of the properties of vulcanite, which was published soon afterward. One of these properties is its remarkably large coefficient of expansion, exceeding that of mercury.

Soon after the publication of Röntgen's discovery of a new species of radiation Professor Mayer's interest in this was aroused, and in June, 1896, he published the outcome of his investigation of herapathite, which had been employed by him to test the possibility of polarizing the Röntgen rays. Formulæ were deduced for the transmissive powers of several substances for these rays, including tourmaline, herapathite, glass, aluminum and platinum.

Professor Mayer's last scientific work was an experimental investigation of the equilibrium of the forces acting in the flotation of discs and rings of metal, and an application of such rings to the determination of the measure of surface tension of liquids. The method was wholly new, and the agreement among results was remarkable. At best, it has been difficult in the past to secure reliable results in work of this kind, and the present work is fully equal, if not superior, to the best hitherto accomplished by Plateau and Quincke. It was done during the intervals between periods of acute physical suffering, and its appearance in the *American Journal of Science* for April of the present year preceded by only a few days the paralytic stroke which demonstrated that the investigator's life work was already ended.

In this brief sketch of Professor Mayer's labors but little has been said of his numerous happy devices for lecture demonstra-

tion. His restless ingenuity was ever ready for any demand, and his mechanical aptitude was so directed by a delicate æsthetic sense that he could never be satisfied with any objective proof which was not neat and simple, as well as adequate. A few of these he published from time to time. Among them may be mentioned methods of measuring the angle of inclination of the mirrors employed in Fresnel's interference experiments; of obtaining a permanent trace of the oscillation plane of the Foucault pendulum; of registering and exhibiting the vibration of rods; of deducing the fundamental laws of electric repulsion by means of the pendulum; of measuring potentials and specific inductive capacities with the spring balance electrometer; of proving Ohm's law, and of expressing electric potential as work. Many of his demonstrations in acoustics were gathered into a small volume on 'Sound,' and have thence been copied into the elementary text-books of to-day. The same may be said of a little volume on 'Light,' prepared with the cooperation of Mr. Charles Barnard. In the student laboratory he was as efficient as in the lecture room, fertile in devices and ever insistent upon a high standard of accuracy. No one knew better than he that demonstration and practice work are of insignificant value in comparison with investigation; but he kept always in mind the fact that, in America at least, the physical investigator is nearly always compelled to be in some way a teacher, and that in teaching physical science demonstration and theoretic instruction must go hand in hand. He was conscious of his skill and, naturally, took keen pleasure in exercising it successfully. That in so doing he gave pleasure and help to others is manifested by the extent to which his methods have served as models.

The manipulative skill and tactile delicacy which are so necessary as adjuncts to independence and ingenuity in the laboratory were applied with no less success by Professor Mayer in out-door recreation. Early in life he became an accomplished marksman; and during manhood, as long as good health lasted, he was an ardent and exceptionally successful sportsman. His field and laboratory interests were combined in his application of the tuning fork to the problems of gunnery. In the *Century Magazine* he published a number of articles on sporting subjects. These were incorporated, along with contributions from other sources, in a volume entitled 'Sport with Rod and Gun in American Woods and Waters.' This volume was edited by Professor Mayer, and for it he specially prepared two valuable articles, one on 'The Shot Gun,' and another on 'The Blow Gun.'

In addition to these literary labors, Professor Mayer contributed many articles to the Cyclopedias of Appleton and Johnson, besides occasional popular articles on scientific subjects for other media of publication. In acknowledgment of his earlier contributions to science the degree of Doctor of Philosophy was accorded him in 1866 by Pennsylvania College. He was admitted to membership in the National Academy of Sciences in 1872, and was a member of each of the leading scientific societies of America, besides being a corresponding member of the British Association. He served during one year, 1873, as an associate editor of the *American Journal of Science*, and during the first eight months of that year five articles from his pen appeared in its pages. The partial failure of his eyesight then necessitated cessation from all work, and a considerable part of the next scholastic year was spent in England, where his reputation had preceded him and where hospitable entertainment was accorded by the most prominent representatives of science.

In the closer circle of personal friendship it is hard to speak with impartiality while the sense of bereavement is still fresh. A man's personality penetrates into all that he does, into his writings quite as unmistakably, if less positively, than into his conversation and the atmosphere of his home. In a eulogy on Joseph Henry, to which I listened at Cambridge just seventeen years ago, Professor Mayer said: "His best eulogy is an account of his discoveries; for a man of science, as such, lives in what he has done, and not in what he has said, nor will he be remembered for what he has proposed to do." In comparing Henry with Faraday he remarked: "Each loved science more than money, and his Creator more than either." Mayer proved himself a worthy pupil of Henry, and their friendship grew in strength until broken by the last great Destroyer. His words may now be properly applied to himself. The characteristics of the gentleman, the high-toned man of honor, were born in him. They needed no cultivation beyond the natural development and confirmation which accompany the attainment of maturity. Those who were favored with his friendship need no reminder of his generosity, his ready sympathy, his quick insight and hearty appreciation, his enthusiasm verging sometimes almost upon that of boyhood.

The value of Mayer's work will be tested by time. For some parts of it he will unquestionably be long referred to as an authority by stranger as well as friend. He dwelt in an atmosphere essentially unfavorable to the spirit which directed his work, for nowhere in the world can there be found so high a degree of general civilization conjoined with so small a degree of general appreciation of pure science as in America. This may be said with full recognition of the abundant rewards here accorded to science successfully applied in industrial fields, and of the rich endowments given by wealthy individuals to some of our educational institutions. But the man who advances theoretical science in America receives not a tithe of the recognition given to the inventor who puts on the market a merchantable device which pleases the multitude. Professor Mayer would have done his scientific work to better advantage in France or Germany. But be this as it may, we who knew him in his work must now know him only in memory. To have had him as a co-worker and friend is now a sad pleasure, and one that nothing can take away.

W. LECONTE STEVENS.

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*ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

ONCE more has the Dominion of Canada invited the British Association for the Advancement of Science to hold one of the annual meetings of its members within the Canadian territory, and for a second time has the Association had the honor and pleasure of accepting the proffered hospitality.

In doing so the Association has felt that, if by any possibility the scientific welfare of a locality is promoted by its being the scene of such a meeting, the claims should be fully recognized of those who, though not dwelling in the British Isles, are still inhabitants of that Greater Britain whose prosperity is so intimately connected with the fortunes of the Mother Country.

Here, especially, as loyal subjects of one beloved sovereign, the sixtieth year of whose beneficent reign has just been celebrated with equal rejoicing in all parts of her Empire; as speaking the same tongue, and as, in most instances, connected by the ties of one common parentage, we are bound together in all that can promote our common interests.

* Delivered by Sir John Evans at Toronto, August 18, 1897.

There is, in all probability, nothing that will tend more to advance those interests than the diffusion of science in all parts of the British Empire, and it is towards this end that the aspirations of the British Association are ever directed, even if in many instances the aim may not be attained.

We are, as already mentioned, indebted to Canada for previous hospitality, but we must also remember that, since the time when we last assembled on this side of the Atlantic, the Dominion has provided the Association with a President, Sir William Dawson, whose name is alike well-known in Britain and America, and whose reputation is indeed world-wide. We rejoice that we have still among us the pioneer of American geology, who, among other discoveries, first made us acquainted with the 'Air-breathers of the Coal,' the terrestrial, or, more properly, arboreal, Saurians of the New Brunswick and Nova Scotia coal-measures.

On our last visit to Canada, in 1884, our place of assembly was Montreal, a city which is justly proud of her McGill University; to-day we meet within the buildings of another of the universities of this vast Dominion, and in a city the absolute fitness of which for such a purpose must have been foreseen by the native Indian tribes when they gave to a small aggregation of huts upon this spot the name of Toronto—'the place of meetings.'

Our gathering this year presents a feature of entire novelty and extreme interest, inasmuch as the sister Association of the United States of America—still mourning the loss of her illustrious President, Professor Cope—and some other learned societies have made special arrangements to allow of their members coming here to join us. I need hardly say how welcome their presence is, nor how gladly we look forward to their taking part in our discussions and aiding us by interchange of thought. To such a meeting the term 'international' seems almost misapplied. It may rather be described as a family gathering, in which our relatives more or less distant in blood, but still intimately connected with us by language, literature and habits of thought, have spontaneously arranged to take part.

The domain of science is no doubt one in which the various nations of the civilized world meet upon equal terms, and for which no other passport is required than some evidence of having striven towards the advancement of natural knowledge. Here, on the frontier between the two great English-speaking nations of the world, who is there that does not inwardly feel that anything which conduces to an intimacy between the representatives of two countries, both of them actively engaged in the pursuit of science, may also, through such an intimacy, react on the affairs of daily life, and aid in preserving those cordial relations that have now for so many years existed between the great American Republic and the British Islands, with which her early foundations are indissolubly connected? The present year has witnessed an interchange of courtesies which has excited the warmest feelings of approbation on both sides of the Atlantic. I mean the return, to its proper custodians, of one of the most interesting of the relics of the Pilgrim Fathers, the Log of the 'Mayflower.' May this return, trifling in itself, be of happy augury as testifying to the feelings of mutual regard and esteem which animate the hearts both of the donors and of the recipients!

At our meeting in Montreal the President was an investigator who had already attained to a foremost place in the domains of physics and mathematics, Lord Rayleigh. In his address he dealt mainly with topics, such as Light, Heat, Sound

and Electricity, on which he is one of our principal authorities. His name and that of his fellow-worker, Professor Ramsay, are now and will in all future ages be associated with the discovery of the new element, Argon. Of the ingenious methods by which that discovery was made and the existence of Argon established, this is not the place to speak. One can only hope that the element will not always continue to justify its name by its inertness.

The claims of such a leader in physical science as Lord Rayleigh to occupy the Presidential chair are self-evident, but possibly those of his successor on this side of the Atlantic are not so immediately apparent. I cannot for a moment pretend to place myself on the same purely scientific level as my distinguished friend and for many years colleague, Lord Rayleigh, and my claims, such as they are, seem to me to rest on entirely different grounds.

Whatever little I may have indirectly been able to do in assisting to promote the advancement of science, my principal efforts have now for many years been directed towards attempting to forge those links in the history of the world, and especially of humanity, that connect the past with the present, and towards tracing that course of evolution which plays as important a part in the physical and moral development of man as it does in that of the animal and vegetable creation.

It appears to me, therefore, that my election to this important post may, in the main, be regarded as a recognition, by this Association, of the value of archæology as a science.

Leaving all personal considerations out of question, I gladly hail this recognition, which is, indeed, in full accordance with the attitude already for many years adopted by the Association towards anthropology, one of the most important branches of true archæology.

It is no doubt hard to define the exact limits which are to be assigned to archæology as a science and archæology as a branch of history and belles-lettres. A distinction is frequently drawn between science, on the one hand, and knowedge or learning, on the other; but translate the terms into Latin, and the distinction at once disappears. In illustration of this, I need only cite Bacon's great work on the 'Advancement of Learning,' which was, with his own aid, translated into Latin under the title '*De Augmentis Scientiarum*.'

It must, however, be acknowledged that a distinction does exist between archæology proper and what, for want of a better word, may be termed Antiquarianism. It may be interesting to know the internal arrangements of a Dominican convent in the Middle Ages; to distinguish between the different mouldings characteristic of the principal styles of Gothic architecture; to determine whether an English coin bearing the name of Henry was struck under Henry II., Richard, John or Henry III., or to decide whether some given edifice was erected in Roman, Saxon or Norman times. But the power to do this, though involving no small degree of detailed knowledge and some acquaintance with scientific methods, can hardly entitle its possessors to be enrolled among the votaries of science.

A familiarity with all the details of Greek and Roman mythology and culture must be regarded as a literary rather than a scientific qualification; and yet when among the records of classical times we come upon traces of manners and customs which have survived for generations, and which seem to throw some rays of light upon the dim past, when history and writing were unknown, we are, I think, approaching the boundaries of scientific archæology.

Every reader of Virgil knows that the Greeks were not merely orators, but that

with a pair of compasses they could describe the movements of the heavens and fix the rising of the stars; but when, by modern astronomy, we can determine the heliacal rising of some well-known star with which the worship in some given ancient temple is known to have been connected, and can fix its position on the horizon at some particular spot, say, three thousand years ago, and then find that the axis of the temple is directed exactly towards that spot, we have some trustworthy scientific evidence that the temple in question must have been erected at a date approximately 1100 years B. C. If on or close to the same site we find that more than one temple was erected, each having a different orientation, these variations, following, as they may fairly be presumed to do, the changing position of the rising of the dominant star, will also afford a guide as to the chronological order of the different foundations. The researches of Mr. Penrose seem to show that in certain Greek temples, of which the date of foundation is known from history, the actual orientation corresponds with that theoretically deduced from astronomical data.

Sir J. Norman Lockyer has shown that what holds good for Greek temples applies to many of far earlier date in Egypt, though up to the present time hardly a sufficient number of accurate observations have been made to justify us in foreseeing all the instructive results that may be expected to arise from astronomy coming to the aid of archæology.

The intimate connection of archæology with other sciences is in no case so evident as with respect to geology, for, when considering subjects such as those I shall presently discuss, it is almost impossible to say where the one science ends and the other begins.

By the application of geological methods many archæological questions relating even to subjects on the borders of the historical period have been satisfactorily solved. A careful examination of the limits of the area over which its smaller coins are found has led to the position of many an ancient Greek city being accurately ascertained; while in England it has only been by treating the coins of the ancient Britons, belonging to a period before the Roman occupation, as if they were actual fossils, that the territories under the dominion of the various kings and princes who struck them have been approximately determined. In arranging the chronological sequence of these coins, the evolution of their types—a process almost as remarkable, and certainly as well defined, as any to be found in nature—has served as an efficient guide. I may venture to add that the results obtained from the study of the morphology of this series of coins were published ten years before the appearance of Darwin's great work on the 'Origin of Species.'

When we come to the consideration of the relics of the early Iron and Bronze Ages the aid of chemistry has, of necessity, to be invoked. By its means we are able to determine whether the iron of a tool or weapon is of meteoritic or volcanic origin, or has been reduced from iron-ore, in which case considerable knowledge of metallurgy would be involved on the part of those who made it. With bronze antiquities the nature and extent of the alloys combined with the copper may throw light not only on their chronological position, but on the sources whence the copper, tin and other metals of which they consist were originally derived. I am not aware of there being sufficient differences in the analyses of the native copper, from different localities in the region in which we are assembled, for Canadian archæologists to fix the sources from which the metal was obtained which was used in the manufacture of the ancient tools and weapons of copper that are occa-

sionally discovered in this part of the globe.

Like chemistry, mineralogy and petrology may be called to the assistance of archæology in determining the nature and source of the rocks of which ancient stone implements are made; and, thanks to researches of the followers of those sciences, the old view that all such implements formed of jade and found in Europe must, of necessity, have been fashioned from material imported from Asia can no longer be maintained. In one respect the archæologist differs in opinion from the mineralogist, namely, as to the propriety of chipping off fragments from perfect and highly finished specimens for the purpose of submitting them to microscopic examination.

I have hitherto been speaking of the aid that other sciences can afford to archæology when dealing with questions that come almost, if not quite, within the fringe of history, and belong to times when the surface of our earth presented much the same configuration as regards the distribution of land and water, and hill and valley, as it does at present, and when, in all probability, the climate was much the same as it now is. When, however, we come to discuss that remote age in which we find the earliest traces that are at present known of man's appearance upon earth the aid of geology and paleontology becomes absolutely imperative.

The changes in the surface configuration and in the extent of the land, especially in a country like Britain, as well as the modifications of the fauna and flora since those days, have been such that the archæologist pure and simple is incompetent to deal with them, and he must either himself undertake the study of these other sciences or call experts in them to his assistance. The evidence that man had already appeared upon the earth is afforded by stone implements wrought by his hands, and it falls strictly within the province of the archæologist to judge whether given specimens were so wrought or not; it rests with the geologist to determine their stratigraphical or chronological position, while the paleontologist can pronounce upon the age and character of the associated fauna and flora.

If left to himself the archæologist seems too prone to build up theories founded upon form alone, irrespective of geological conditions. The geologist, unaccustomed to archæological details, may readily fail to see the difference between the results of the operations of nature and those of art, and may be liable to trace the effects of man's handiwork in the chipping, bruising and wearing which in all ages result from natural forces; but the united labors of the two, checked by those of the paleontologist, cannot do otherwise than lead towards sound conclusions.

It will, perhaps, be expected of me that I should on the present occasion bring under review the state of our present knowledge with regard to the antiquity of man; and probably no fitter place could be found for the discussion of such a topic than the adopted home of my venerated friend, the late Sir Daniel Wilson, who first introduced the word 'prehistoric' into the English language.

Some among us may be able to call to mind the excitement not only among men of science, but among the general public, when, in 1859, the discoveries of M. Boucher de Perthes and Dr. Rigollot in the gravels of the valley of the Somme, at Abbeville and Amiens, were confirmed by the investigations of the late Sir Joseph Prestwich, myself and others, and the co-existence of man with the extinct animals of the Quaternary fauna, such as the mammoth and woolly-haired rhinoceros, was first virtually established. It was at the same time pointed out that these relics belonged to a far earlier date than the ordinary stone weapons found

upon the surface, which usually showed signs of grinding or polishing, and that in fact there were two Stone Ages in Britain. To these the terms Neolithic and Paleolithic were subsequently applied by Sir John Lubbock.

The excitement was not less when, at the meeting of this Association at Aberdeen in the autumn of that year, Sir Charles Lyell, in the presence of the Prince Consort, called attention to the discoveries in the valley of the Somme, the site of which he had himself visited, and to the vast lapse of time indicated by the position of the implements in drift-deposits a hundred feet above the existing river.

The conclusions forced upon those who examined the facts on the spot did not receive immediate acceptance by all who were interested in geology and archæology, and fierce were the controversies on the subject that were carried on both in the newspapers and before various learned societies.

It is at the same time instructive and amusing to look back on the discussions of those days. While one class of objectors accounted for the configuration of the flint implements from the gravels by some unknown chemical agency, by the violent and continued gyratory action of water, by fracture resulting from pressure, by rapid cooling when hot or by rapid heating when cold, or even regarded them as aberrant forms of fossil fishes, there were others who, when compelled to acknowledge that the implements were the work of men's hands, attempted to impugn and set aside the evidence as to the circumstances under which they had been discovered. In doing this they adopted the view that the worked flints had either been introduced into the containing beds at a comparatively recent date, or if they actually formed constituent parts of the gravel then that this is a mere modern alluvium resulting from floods at no very remote period.

In the course of a few years the main stream of scientific thought left this controversy behind, though a tendency to cut down the lapse of time necessary for all the changes that have taken place in the configuration of the surface of the earth and in the character of its occupants since the time of the Paleolithic gravels, still survives in the inmost recesses of the hearts of not a few observers.

In his address to this Association at the Bath meeting of 1864, Sir Charles Lyell struck so true a note that I am tempted to reproduce the paragraph to which I refer:

"When speculations on the long series of events which occurred in the glacial and post-glacial periods are indulged in, the imagination is apt to take alarm at the immensity of the time required to interpret the monuments of these ages, all referable to the era of existing species. In order to abridge the number of centuries which would otherwise be indispensable, a disposition is shown by many to magnify the rate of change in prehistoric times by investing the causes which have modified the animate and inanimate world with extraordinary and excessive energy. It is related of a great Irish orator of our day that when he was about to contribute somewhat parsimoniously towards a public charity he was persuaded by a friend to make a more liberal donation. In doing so he apologized for his first apparent want of generosity by saying that his early life had been a constant struggle with scanty means, and that 'they who are born to affluence cannot easily imagine how long a time it takes to get the chill of poverty out of one's bones.' In like manner, we of the living generation, when called upon to make grants of thousands of centuries in order to explain the events of what is called the modern period, shrink naturally at first from making what seems so lavish an expenditure of past time. Throughout our early education we have

been accustomed to such strict economy in all that relates to the chronology of the earth and its inhabitants in remote ages, so fettered have we been by old traditional beliefs, that even when our reason is convinced, and we are persuaded that we ought to make more liberal grants of time to the geologist, we feel how hard it is to get the chill of poverty out of our bones."

Many, however, have at the present day got over this feeling, and of late years the general tendency of those engaged upon the question of the antiquity of the human race has been in the direction of seeking for evidence by which the existence of man upon the earth could be carried back to a date earlier than that of the Quaternary gravels.

There is little doubt that such evidence will eventually be forthcoming, but, judging from all probability, it is not in northern Europe that the cradle of the human race will eventually be discovered, but in some part of the world more favored by a tropical climate, where abundant means of subsistence could be procured, and where the necessity for warm clothing did not exist.

Before entering into speculations on this subject, or attempting to lay down the limits within which we may safely accept recent discoveries as firmly established, it will be well to glance at some of the cases in which implements are stated to have been found under circumstances which raise a presumption of the existence of man in pre-Glacial, Pliocene, or even Miocene times.

Flint implements of ordinary Paleolithic type have, for instance, been recorded as found in the eastern counties of England, in beds beneath the chalky boulder clay; but on careful examination the geological evidence has not, to my mind, proved satisfactory, nor has it, I believe, been generally accepted. Moreover, the archæological difficulty that man, at two such remote epochs as the pre-Glacial and the post-Glacial, even if the term Glacial be limited to the chalky boulder clay, should have manufactured implements so identical in character that they cannot be distinguished apart seems to have been entirely ignored.

Within the last few months we have had the report of worked flints having been discovered in the late Pliocene Forest Bed of Norfolk, but in that instance the signs of human workmanship upon the flints are by no means apparent to all observers.

But such an antiquity as that of the Forest Bed is as nothing when compared with that which would be implied by the discoveries of the work of men's hands in the Pliocene and Miocene beds of England, France, Italy and Portugal, which have been accepted by some geologists. There is one feature in these cases which has hardly received due attention, and that is the isolated character of the reputed discoveries. Had man, for instance, been present in Britain during the Crag Period, it would be strange, indeed, if the sole traces of his existence that he left were a perforated tooth of a large shark, the sawn rib of a manatee, and a beaming full face, carved on the shell of a pectunculus!

In an address to the Anthropological Section at the Leeds meeting of this Association in 1890 I dealt somewhat fully with these supposed discoveries of the remains of human art in beds of Tertiary date, and I need not here go further into the question. Suffice it to say that I see no reason why the verdict of 'not proven' at which I then arrived should be reversed.

In the case of a more recent discovery in Upper Burma, in beds at first pronounced to be Upper Miocene, but subsequently 'definitely ascertained to be Pliocene,' some of the flints are of purely natural and not artificial origin, so that two questions arise: First, were the fossil remains associ-

ated with the worked flints or with those of natural forms? And second, were they actually found in the bed to which they have been assigned, or did they merely lie together on the surface?

Even the *Pithecanthropus erectus* of Dr. Eugène Dubois from Java meets with some incredulous objectors from both the physiological and the geological sides. From the point of view of the latter the difficulty lies in determining the exact age of what are apparently alluvial beds in the bottom of a river valley.

When we return to Paleolithic man it is satisfactory to feel that we are treading on comparatively secure ground, and that the discoveries of the last forty years in Britain alone enable us to a great extent to reconstitute his history. We may not know the exact geological period when first he settled in the British area, but we have good evidence that he occupied it at a time when the configuration of the surface was entirely different from what it is at present; when the river valleys had not been cut down to anything like their existing depth; when the fauna of the country was of a totally different character from that of the present day; when the extension of the southern part of the island seaward was in places such that the land was continuous with that of the continent, and when in all probability a far more rainy climate prevailed. We have proofs of the occupation of the country by man during the long lapse of time that was necessary for the excavation of the river valleys. We have found the old floors on which his habitations were fixed; we have been able to trace him at work on the manufacture of flint instruments, and by building up the one upon the other the flakes struck off by the primæval workman in those remote times we have been able to reconstruct the blocks of flint which served as his material.

That the duration of the Palæolithic Period must have extended over an almost incredible length of time is sufficiently proved by the fact that valleys, some miles in width and of a depth of from 100 to 150 feet, have been eroded since the deposit of the earliest implement-bearing beds. Nor is the apparent duration of this period diminished by the consideration that the floods which hollowed out the valleys were not in all probability of such frequent occurrence as to teach Palæolithic man by experience the danger of settling too near to the streams, for had he kept to the higher slopes of the valley there would have been but little chance of his implements having so constantly formed constituent parts of the gravels deposited by the floods.

The examination of British cave-deposits affords corroborative evidence of this extended duration of the Paleolithic Period. In Kent's Cavern, at Torquay, for instance, we find in the lowest deposit, the breccia below the red cave-earth, implements of flint and chert corresponding, in all respects, with those of the high level and most ancient river gravels. In the cave-earth these are scarcer, though implements occur which also have their analogues in the river deposits; but, what is more remarkable, harpoons of reindeer's horn and needles of bone are present, identical in form and character with those of the caverns of the Reindeer Period in the south of France, and suggestive of some bond of union or identity of descent between the early troglodytes, whose habitations were geographically so widely separated the one from the other.

In a cavern at Creswell Crags, on the confines of Derbyshire and Nottinghamshire, a bone has, moreover, been found engraved with a representation of parts of a horse in precisely the same style as the engraved bones of the French caves.

It is uncertain whether any of the river-

drift specimens belong to so late a date as these artistic cavern-remains, but the greatly superior antiquity of even these to any Neolithic relics is testified by the thick layer of stalagmite which had been deposited in Kent's Cavern before its occupation by men of the Neolithic and Bronze Periods.

Towards the close of the period covered by the human occupation of the French caves there seems to have been a dwindling in the number of the larger animals constituting the Quaternary fauna, whereas their remains are present in abundance in the lower and, therefore, more recent of the valley gravels. This circumstance may afford an argument in favor of regarding the period represented by the later French caves as a continuation of that during which the old river gravels were deposited, and yet the great change in the fauna that has taken place since the latest of the cave-deposits included in the Paleolithic Period is indicative of an immense lapse of time.

How much greater must have been the time required for the more conspicuous change between the old Quaternary fauna of the river gravels and that characteristic of the Neolithic Period!

As has been pointed out by Professor Boyd Dawkins, only thirty-one out of the forty-eight well-ascertained species living in the post-Glacial or River-drift Period survived into pre-historic or Neolithic times. We have not, indeed, any means at command for estimating the number of centuries which such an important change indicates; but when we remember that the date of the commencement of the Neolithic or Surface Stone Period is still shrouded in the mist of a dim antiquity, and that prior to that commencement the River-drift Period had long come to an end; and when we further take into account the almost inconceivable ages that even under the most favorable conditions the excavation of wide and deep valleys by river action implies, the remoteness of the date at which the Paleolithic Period had its beginning almost transcends our powers of imagination.

We find distinct traces of river action from 100 to 200 feet above the level of existing streams and rivers, and sometimes at a great distance from them; we observe old fresh-water deposits on the slopes of valleys several miles in width; we find that long and lofty escarpments of rock have receded unknown distances since their summits were first occupied by Paleolithic man; we see that the whole side of a wide river valley has been carried away by an invasion of the sea, which attacked and removed a barrier of chalk cliffs from 400 to 600 feet in height; we find that what was formerly an inland river has been widened out into an arm of the sea, now the highway of our fleets, and that gravels which were originally deposited in the bed of some ancient river now cap isolated and lofty hills.

And yet, remote as the date of the first known occupation of Britain by man may be, it belongs to what, geologically speaking, must be regarded as a quite recent period, for we are now in a position to fix, with some degree of accuracy, its place on the geological scale. Thanks to investigations ably carried out at Hoxne in Suffolk, and at Hitchin in Hertfordshire, by Mr. Clement Reid, under the auspices of this Association and of the Royal Society, we know that the implement-bearing beds at those places undoubtedly belong to a time subsequent to the deposit of the great chalky boulder clay of the eastern counties of England. It is, of course, self-evident that this vast deposit, in whatever manner it may have been formed, could not, for centuries after its deposition was complete, have presented a surface inhabitable by man. Moreover, at a distance but little farther north, beds exist which also, though at a somewhat later date, were apparently formed under glacial con-

ditions. At Hoxne the interval between the deposit of the boulder clay and of the implement-bearing beds is distinctly proved to have witnessed at least two noteworthy changes in climate. The beds immediately reposing on the clay are characterized by the presence of alder in abundance, of hazel and yew, as well as by that of numerous flowering plants indicative of a temperate climate very different from that under which the boulder clay itself was formed. Above these beds characterized by temperate plants comes a thick and more recent series of strata, in which leaves of the dwarf arctic willow and birch abound, and which were in all probability deposited under conditions like those of the cold regions of Siberia and North America.

At a higher level and of more recent date than these—from which they are entirely distinct—are the beds containing Paleolithic implements, formed in all probability under conditions not essentially different from those of the present day. However this may be, we have now conclusive evidence that the Paleolithic implements are in the eastern counties of England of a date long posterior to that of the great chalky boulder clay.

It may be said, and said truly, that the implements at Hoxne cannot be shown to belong to the beginning rather than to some later stage of the Paleolithic Period. The changes, however, that have taken place at Hoxne in the surface configuration of the country prove that the beds containing the implements cannot belong to the close of that period.

It must, moreover, be remembered that in what are probably the earliest of the Paleolithic deposits of the eastern counties, those at the highest level, near Brandon in Norfolk, where the gravels contain the largest proportion of pebbles derived from Glacial beds, some of the implements themselves have been manufactured from materials not native to the spot, but brought from a distance, and derived in all probability either from the boulder clay or from some of the beds associated with it.

We must, however, take a wider view of the whole question, for it must not for a moment be supposed that there are the slightest grounds for believing that the civilization, such as it was, of the Paleolithic Period originated in the British Isles. We find in other countries implements so identical in form and character with British specimens that they might have been manufactured by the same hands. These occur over large areas in France under similar conditions to those that prevail in England. The same forms have been discovered in the ancient river gravels of Italy, Spain and Portugal. Some few have been recorded from Africa, and analogous types occur in considerable numbers in the south of that continent. On the banks of the Nile, many hundreds of feet above its present level, implements of the European types have been discovered; while in Somaliland, in an ancient river valley at a great elevation above the sea, Mr. Seton-Karr has collected a large number of implements formed of flint and quartzite, which, judging from their form and character, might have been dug out of the drift deposits of the Somme or the Seine, the Thames or the ancient Solent.

In the valley of the Euphrates implements of the same kind have also been found, and again farther east, in the lateritic deposits of southern India, they have been obtained in considerable numbers. It is not a little remarkable, and is at the same time highly suggestive, that a form of implement almost peculiar to Madras reappears among implements from the very ancient gravels of the Manzanares at Madrid. In the case of the African discoveries we have as yet no definite paleontological evidence by which to fix their antiquity,

but in the Narbadá valley of western India Paleolithic implements of quartzite seem to be associated with a local fauna of Pleistocene age, comprising, like that of Europe, the elephant, hippopotamus, ox and other mammals of species now extinct. A correlation of the two faunas with a view of ascertaining their chronological relations is beset with many difficulties, but there seems reason for accepting this Indian Pleistocene fauna as in some degree more ancient than the European.

Is this not a case in which the imagination may be fairly invoked in aid of science? May we not from these data attempt, in some degree, to build up and reconstruct the early history of the human family? There, in eastern Asia, in a tropical climate, with the means of subsistence readily at hand, may we not picture to ourselves our earliest ancestors gradually developing from a lowly origin, acquiring a taste for hunting, if not indeed being driven to protect themselves from the beasts around them, and evolving the more complicated forms of tools or weapons from the simpler flakes which had previously served them as knives? May we not imagine that, when once the stage of civilization denoted by these Paleolithic implements had been reached, the game for the hunter became scarcer, and that his life, in consequence, assumed a more nomad character? Then, and possibly not till then, may a series of migrations to 'fresh woods and pastures new' not unnaturally have ensued, and these, following the usual course of 'westward towards the setting sun,' might eventually lead to a Paleolithic population finding its way to the extreme borders of western Europe, where we find such numerous traces of its presence.

How long a term of years may be involved in such a migration it is impossible to say, but that such a migration took place the phenomena seem to justify us in believing. It can hardly be supposed that the process that I have shadowed forth was reversed, and that man, having originated in northwestern Europe, in a cold climate, where clothing was necessary and food scarce, subsequently migrated eastward to India and southward to the Cape of Good Hope! As yet, our records of discoveries in India and eastern Asia are but scanty; but it is there that the traces of the cradle of the human race are, in my opinion, to be sought, and possibly future discoveries may place upon a more solid foundation the visionary structure that I have ventured to erect.

It may be thought that my hypothesis does not do justice to what Sir Thomas Browne has so happily termed 'that great antiquity, America.' I am, however, not here immediately concerned with the important Neolithic remains of all kinds with which this great continent abounds. I am now confining myself to the question of Paleolithic man and his origin, and in considering it I am not unmindful of the Trenton implements, though I must content myself by saying that the 'turtle-back' form is essentially different from the majority of those on the wide dissemination of which I have been speculating, and, moreover, as many here present are aware, the circumstances of the finding of these American implements are still under careful discussion.

Leaving them out of the question for the present, it may be thought worth while to carry our speculations rather further, and to consider the relations in time between the Paleolithic and the Neolithic Periods. We have seen that the stage in human civilization denoted by the use of the ordinary forms of Paleolithic implements must have extended over a vast period of time if we have to allow for the migration of the primeval hunters from their original home, wherever it may have been in Asia

or Africa, to the west of Europe, including Britain. We have seen that, during this migration, the forms of the weapons and tools made from silicious stones had become, as it were, stereotyped, and further, that, during the subsequent extended period implied by the erosion of the valleys, the modifications in the form of the implements and the changes in the fauna associated with the men who used them were but slight.

At the close of the period during which the valleys were being eroded comes that represented by the latest occupation of the caves by Paleolithic man, when both in Britain and in the south of France the reindeer was abundant; but among the stone weapons and implements of that long troglodytic phase of man's history not a single example with the edge sharpened by grinding has as yet been found. All that can safely be said is that the larger implements as well as the larger mammals had become scarcer, that greater power in chipping flint had been attained, that the arts of the engraver and the sculptor had considerably developed, and that the use of the bow had probably been discovered.

Directly we encounter the relics of the Neolithic Period, often, in the case of the caves lately mentioned, separated from the earlier remains by a thick layer of underlying stalagmite, we find flint hatchets polished at the edge and on the surface, cutting at the broad and not at the narrow end, and other forms of implements associated with a fauna in all essential respects identical with that of the present day.

Were the makers of these polished weapons the direct descendants of Paleolithic ancestors whose occpation of the country was continuous from the days of the old river gravels? or had these long since died out, so that after western Europe had for ages remained uninhabited it was repeopled in Neolithic times by the immigration of some new race of men? Was there, in fact, a 'great gulf fixed' between the two occupations? or was there in Europe a gradual transition from the one stage of culture to the other?

It has been said that "what song the Syrens sang, or what name Achilles assumed when he hid himself among women, though puzzling questions, are not beyond all conjecture;" and though the questions now proposed may come under the same category, and must await the discovery of many more essential facts before they receive definite and satisfactory answers, we may, I think, throw some light upon them if we venture to take a few steps upon the seductive if insecure paths of conjecture. So far as I know, we have as yet no trustworthy evidence of any transition from the one age to the other, and the gulf between them remains practically unbridged. We can, indeed, hardly name the part of the world in which to seek for the cradle of Neolithic civilization, though we know that traces of what appear to have been a stone-using people have been discovered in Egypt, and that what must be among the latest of the relics of their industry have been assigned to a date some 3,500 to 4,000 years before our era. The men of that time had attained to the highest degree of skill in working flint that has ever been reached. Their beautifully made knives and spear-heads seem indicative of a culminating point reached after long ages of experience; but whence these artists in flint came or who they were is at present absolutely unknown, and their handiworks afford no clue to help us in tracing their origin.

Taking a wider survey, we may say that, generally speaking, not only the fauna, but the surface configuration of the country were, in western Europe at all events, much the same at the commencement of the Neolithic Period as they are at the present day. We have, too, no geological

indications to aid us in forming any chronological scale.

The occupation of some of the caves in the south of France seems to have been carried on after the erosion of the neighboring river valleys had ceased, and so far as our knowledge goes these caves offer evidence of being the latest in time of those occupied by man during the Paleolithic Period. It seems barely possible that, though in the north of Europe there are no distinct signs of such late occupation, yet that, in the south, man may have lived on, though in diminished numbers; and that in some of the caves, such, for instance, as those in the neighborhood of Mentone, there may be traces of his existence during the transitional period that connects the Paleolithic and Neolithic Ages. If this were really the case we might expect to find some traces of a dissemination of Neolithic culture from a north Italian center, but I much doubt whether any such traces actually exist.

If it had been in that part of the world that the transition took place, how are we to account for the abundance of polished stone hatchets found in central India? Did Neolithic man return eastward by the same route as that by which in remote ages his Paleolithic predecessor had migrated westward? Would it not be in defiance of all probability to answer such a question in the affirmative? We have, it must be confessed, nothing of a substantial character to guide us in these speculations; but, pending the advent of evidence to the contrary, we may, I think, provisionally adopt the view that, owing to the failure of food, climatal changes or other causes, the occupation of western Europe by Paleolithic man absolutely ceased, and that it was not until after an interval of long duration that Europe was re-peopled by a race of men immigrating from some other part of the globe where the human race had survived, and in course of ages had developed a higher stage of culture than that of Paleolithic man.

I have been carried away by the liberty allowed for conjecture into the regions of pure imagination, and must now return to the realms of fact, and one fact on which I desire for a short time to insist is that of the existence at the present day, in close juxtaposition with our own civilization, of races of men who, at all events but a few generations ago, lived under much the same conditions as did our own Neolithic predecessors in Europe.

The manners and customs of these primitive tribes and peoples are changing day by day, their languages are becoming obsolete, their myths and traditions are dying out, their ancient processes of manufacture are falling into oblivion, and their numbers are rapidly diminishing, so that it seems inevitable that ere long many of these interesting populations will become absolutely extinct. The admirable Bureau of Ethnology instituted by our neighbors in the United States of America has done much towards preserving a knowledge of the various native races in this vast continent, and here in Canada the annual Archæological Reports presented to the Minister of Education are rendering good service in the same cause.

Moreover, the committee of this Association appointed to investigate the physical characters, languages and industrial and social conditions of the Northwestern tribes of the Dominion of Canada is about to present its twelfth and final report, which, in conjunction with those already presented, will do much towards preserving a knowledge of the habits and languages of those tribes. It is sad to think that Mr. Horatio Hale, whose comprehensive grasp of the bearings of ethnological questions, and whose unremitting labors have so materially conduced to the success of the com-

mittee, should be no longer among us. Although this report is said to be final, it is to be hoped that the committee may be able to indicate lines upon which future work in the direction of ethnological and archæological research may be profitably carried on in this part of Her Majesty's dominions.

It is, however, lamentable to notice how little is being or has been officially done towards preserving a full record of the habits, beliefs, arts, myths, languages and physical characteristics of the countless other tribes and nations more or less uncivilized which are comprised within the limits of the British Empire. At the meeting of this Association held last year at Liverpool it was resolved by the General Committee "that it is of urgent importance to press upon the government the necessity of establishing a Bureau of Ethnology for Greater Britain, which, by collecting information with regard to the native races within and on the borders of the Empire, will prove of immense value to science and to the government itself." It has been suggested that such a bureau might, with the greatest advantage and with the least outlay and permanent expense, be connected either with the British Museum or with the Imperial Institute, and the project has already been submitted for the consideration of the trustees of the former establishment.

The existence of an almost unrivalled ethnological collection in the Museum, and the presence there of officers already well versed in ethnological research, seem to afford an argument in favor of the proposed bureau being connected with it. On the other hand, the Imperial Institute was founded with an especial view to its being a center around which every interest connected with the dependencies of the Empire might gather for information and support. The establishment, within the last twelve months of a scientific department within the Institute, with well-appointed laboratories and a highly trained staff, shows how ready are those concerned in its management to undertake any duties that may conduce to the welfare of the outlying parts of the British Empire; a fact of which I believe that Canada is fully aware. The Institute is, therefore, likely to develop, so far as its scientific department is concerned, into a bureau of advice in all matters scientific and technical, and certainly a Bureau of Ethnology, such as that suggested, would not be out of place within its walls.

Wherever such an institution is to be established, the question of its existence must, of necessity, rest with Her Majesty's government and treasury, inasmuch as without funds, however moderate, the undertaking cannot be carried on. I trust that in considering the question it will always be borne in mind that in the relations between civilized and uncivilized nations and races it is of the first importance that the prejudices, and especially the religious or semi-religious and caste prejudices, of the latter should be thoroughly well known to the former. If but a single 'little war' could be avoided in consequence of the knowledge acquired and stored up by the Bureau of Ethnology preventing such a misunderstanding as might culminate in warfare, the cost of such an institution would quickly be saved.

I fear that it will be thought that I have dwelt too long on primeval man and his modern representatives, and that I should have taken this opportunity to discuss some more general subject, such as the advances made in the various departments of science since last this Association met in Canada. Such a subject would, no doubt, have afforded an infinity of interesting topics on which to dilate. Spectrum analysis, the origin and nature of celestial bodies, photography, the connection between heat, light and elec-

tricity, the practical applications of the latter, terrestrial magnetism, the liquefaction and solidification of gases, the behavior of elements and compounds under the influence of extreme cold, the nature and uses of the Röntgen rays, the advances in bacteriology and in prophylactic medicine, might all have been passed under review, and to many of my audience would have seemed to possess greater claims to attention than the subject that I have chosen.

It must, however, be borne in mind that most, if not indeed all, of these topics will be discussed by more competent authorities in the various Sections of the Association by means of the Presidential addresses or otherwise. Nor must it be forgotten that I occupy this position as a representative of archæology, and am therefore justified in bringing before you a subject in which every member of every race of mankind ought to be interested—the antiquity of the human family and the scenes of its infancy.

Others will direct our thoughts in other directions, but the farther we proceed the more clearly shall we realize the connection and inter-dependence of all departments of science. Year after year, as meetings of this Association take place, we may also foresee that 'many shall run to and fro and knowledge shall be increased.' Year after year advances will be made in science and in reading that Book of Nature that lies ever open before our eyes; successive stones will be brought for building up that Temple of Knowledge of which our fathers and we have labored to lay the foundations. May we not well exclaim with old Robert Recorde?—

"Oh woorthy temple of Goddes magnificence: Oh throne of glorye and seate of the lorde: thy substance most pure what tonge can describe? thy signes are so wonderous, surmountinge mannes witte, the effects of thy motions so diuers in kinde: so harde for to searche, and worse for to fynde—Thy woorkes are all wondrous, thy cunning unknowen: yet seedes of all knowledge in that booke are sowen—And yet in that boke who rightly can reade, to all secrete knowledge it will him straighte leade."*

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## *AMERICAN ASSOCIATION FOR ADVANCEMENT OF SCIENCE: FORTY-SIXTH MEETING, DETROIT, AUGUST 7–13, 1897.*

THE second Detroit meeting of the American Association for the Advancement of Science began on Saturday, August 7, 1897, with a slimly attended meeting of the Council at the Hotel Cadillac. As last year, the first general session was held Monday morning, and the last on Friday evening. The general sessions and all meetings of sections were held in the new Central High School building, which is excellently adapted for the purpose. Superintendent Bliss and the school authorities made every effort to assist the Association.

Monday evening a reception to the Association was given at the High School by the local committee. Thursday afternoon Section G, together with the officers and guests of the Association, were invited to a garden party by Mr. Joseph Berry, of Grosse Pointe. Friday evening there was a reception at the High School building after the final session, and Saturday, August 14th, was given to an excursion to the Ste Claire flats.

The arrangements and management of the local committee were excellent in every respect, and the Detroit meeting, which it was feared would be a failure, was a very successful one. On account of the meeting of the British Association at Toronto, the attendance at Detroit was small, the total registration being only 291. There were present a number of foreign guests, among them being Messrs. A. G. Greenhill, W. E. Hoyle, A. W. Scott, J. Thorp, D. H. Mar-

*Preface to Robert Recorde's *Castle of Knowledge*, 1556.

shall, W. Doberck, R. Munro, R. Gowing, A. B. Macallum, A. G. Vernon-Harcourt, W. Duddell, J. L. Myres, A. Penck, E. B. Poulton and Prince Krapotkin. There were elected 126 new members, and 50 members were made fellows.

On account of the death of retiring President Cope, the Monday morning session was opened by Dr. Theodore Gill, the senior Vice-President of the Buffalo meeting. He introduced W J McGee, acting President of the Detroit meeting and serving in the place of Dr. Wolcott Gibbs, who was ill and was forbidden by his physician to be present. The vacancies in the chairmanships of Sections F and E, Zoology and Geology, caused by the decease of G. Browne Goode and the absence of Professor White, were filled by the selection of L. O. Howard and E. W. Claypole.

Besides the morning meetings, the Council held three long evening sessions. It was urged very strongly that the methods of business procedure of the Association needed to be simplified, and as the first step in this direction certain amendments proposed before the general session in 1896 were recommended for passage by the Association and after presentation to it were passed. These amendments leave the selection of officers and the fixing of the place of meeting wholly in the hands of the Nominating Committee. Also, the power of Council was somewhat extended, the plan being to give it still further powers.

Section H, Anthropology, was granted permission by the Council to hold a winter meeting.

Messrs. Colburn, Morse, Prescott, Woodward and Howard were appointed a committee to secure uniform nomenclature in scientific terms used in commerce. A report prepared by Mr. Colburn was accepted by the committee, and the Council ordered the report to be printed by the Permanent Secretary.

The movement to raise funds for a statue of Gallileo Ferraris was recommended to the favorable consideration of the Association.

The action taken at the Buffalo meeting, whereby the annual volume was considerably abridged, was repealed.

A grant of $100 from the research fund was made to the marine biological laboratory at Woods Holl, the committee on the laboratory for 1898 to consist of the outgoing and incoming Vice-Presidents of Sections F and G, together with the director of the laboratory.

The following were appointed a committee on extending the influence of the Association into the secondary schools: E. S. Morse, W. Orr, Jr., T. C. Chamberlin.

The special committees of the Association were continued, the personnel of *4*, on the policy of the Association, being changed slightly, so as to consist of the President, Permanent Secretary and Treasurer, *ex-officio*, together with Messrs. L. O. Howard, W. H. Brewer, T. C. Mendenhall and Mansfield Merriman. No report was received from *6*, on standard colors and standard nomenclature of colors, but it was understood that much work had been done by the committee.

On Friday morning, in general session, the resignation of Permanent Secretary Putnam was announced. Also, the selection of Boston as the place of meeting for 1898, the jubilee year of the Association. Also, the choice of the following officers for 1898:

President—F. W. Putnam, Cambridge, Mass.

Permanent Secretary—L. O. Howard, Washington, D. C.

General Secretary—D. S. Kellicott, Columbus, O.

Council Secretary—F. Bedell, Ithaca, N. Y.

Treasurer—R. S. Woodward, New York.

Vice-Presidents—Mathematics and As-

tronomy, E. E. Barnard, University of Chicago; Physics, Frank P. Whitman, Adelbert College, Cleveland; Chemistry, Edgar F. Smith, University of Pennsylvania; Mechanical Science and Engineering, M. E. Cooley, University of Michigan; Geology and Geography, H. L. Fairchild, Rochester University; Zoology, A. S. Packard, Brown University, Providence, R. I.; Botany, W. F. Farlow, Harvard University; Anthropology, J. McKeen Cattell, Columbia University; Economic Science and Statistics, Archibald Blue, Director of Bureau of Mines, Toronto, Canada.

Secretaries of the Sections—Mathematics and Astronomy, Alexander Ziwet, University of Michigan; Physics, E. B. Ross, Wesleyan University; Chemistry, Charles Baskerville, University of North Carolina; Mechanical Science and Engineering, Wm. S. Aldrich, University of West Virginia; Geology and Geography, Warren Upham, St. Paul, Minn; Zoology, C. W. Stiles, Department of Agriculture, Washington, D. C.; Botany, Erwin F. Smith, Department of Agriculture, Washington, D. C.; Anthropology, M. H. Saville, American Museum of Natural History, New York City; Economic Science and Statistics, Marcus Benjamin, U. S. National Museum, Washington, D. C.

On Friday evening there was a general session at which the usual complimentary resolutions were passed, after which the 46th meeting of the Association was declared adjourned. As has been said, this was an unusually good meeting. The scientific papers were above the average, and the sections were well attended by citizens of Detroit as well as by members. A number of the distinguished foreign guests gave papers and took part in the discussions.

During the Association week meetings were held by the American Chemistry Society, the Society for the Promotion of Agricultural Science, the Society of Economic Entomologists and the Michigan Academy of Sciences. Some of these meetings were held jointly with sections of the American Association. It is believed that by offering proper courtesies to the affiliated societies more of these joint meetings can be held, to the great advantage of the Association and of the societies themselves.

ASAPH HALL, JR.,
*General Secretary.*

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## *CURRENT NOTES ON PHYSIOGRAPHY.*

### THE ATHABASCA REGION.

TYRRELL'S report on the country between Athabasca lake and Churchill river (Geol. Surv. Canada, Ann. Rep., VIII., for 1895–1897) divides the region into Archæan and Cambrian areas. The first is occupied by low rocky hills and ridges from fifty to a hundred and fifty feet in local relief, separated by drift-covered depressions, wooded or interrupted by small irregular lakes. The second is a monotonous district of horizontal sandstones, forming a sterile plain, thinly wooded, with few lakes. The absence of deep valleys and the occurrence of lakes and rapids shows that the drainage is very new. It is suggested that Athabaska lake occupies a pre-glacial valley, excavated along the northern boundary of the sandstone area, when the land thereabouts stood higher or sloped more to the west. Till is scanty on the Archæan area, but more plentiful on the sandstone plain. Rugged moraines are found further southwest, like Duck and Riding mountains, in Manitoba. The most interesting drift hills of the region are steep, narrow ridges, half a mile or more in length, averaging 120 feet in height, standing parallel to the line of glacial motion and rounding down gently at both ends. Unlike drumlins, they consist of unassorted rock flour mixed with boulders, and they all lie on the floors of large post-glacial lakes, now drained. They are explained as deposits in quiet water occupying ice gorges, and Tyrell calls them

'ispatinows,' the Cree work for a conspicuous hill. They seem to be similar to the 'paha' described by McGee in Iowa. The prefix 'Hyper' is used with the name of existing lakes, to indicate their glacial expansion to greater height and area.

SENECA COUNTY, N. Y.

The Annual Report of the State Geologist of New York for 1894 (lately received) contains an account of Seneca county by D. F. Lincoln. The northern part of the county includes a part of the Ontario plain, varied chiefly by long narrow drumlins. Southward from the plain a gradual ascent is made to the upland, here dissected by the deep sub-parallel troughs of Cayuga and Seneca lakes. Near the southern border, great flat hills rise several hundred feet above the upland, these being outliers of Portage strata from the higher Allegheny plateau further south. The slope from the upland into the lake troughs is notably smooth, being furrowed only by post-glacial ravines in which cliffs and falls are picturesquely developed; but in pre-glacial time the slopes must have been more furrowed, inasmuch as several side valleys now appear to be obliterated by drift filling.

DRAINAGE MAP OF RHODE ISLAND.

The 18th Annual Report of the Rhode Island Board of Health contains a contour map of the drainage areas on a scale of four miles to an inch, based on the topographical State map and prepared by D. W. Hoyt. The terminal moraine near the south coast forms a divide by which the Pawcatuck and its tributaries from among the hills are turned westward, instead of flowing directly to the ocean. It is noted that Moshassuck valley, west of Providence, was probably the pre-glacial course of the Blackstone, which now flows east of the city into the head of Narragansett bay. The present course of the river is interrupted by ledges, furnishing water power that is actively employed at Valley Falls and Pawtucket; the inferred pre-glacial course is obstructed by drift, in which driven wells are supplied with water from a 'subterranean Blackstone.'

POPOCATAPETL AND IXTACCIHUATL.

A series of interesting and well illustrated observations on the two great Mexican mountains, by O. C. Farrington, forms publication 18 of the Field Columbian Museum, of Chicago (Geol. Series, Vol. I., No. 2). The upper cone of Popocatapetl, clothed with sand and snow, has a nearly uniform slope; the middle portion is carved by numerous channels; "the lower portion is involved in the tortuous folds which make up the Sierra." The summit crater is a pit, 2,000 feet in greater diameter, 1,300 feet in lesser diameter, and from 800 to 1,500 feet deep, from whose walls of discordant lava beds and breccia rocks continually fall to the bottom. The cumulus clouds that frequently envelop the mountain flank in the afternoon are (erroneously?) ascribed to cooling caused by snow. Ixtaccihuatl is described as of more massive and uniform structure, and without distinct crater, as if the product of fissure erruption; but as mention is made of lava beds on its flanks, weathered to deep soil near the base and dissected into ragged spurs on the slopes, it seems possible that long continued erosion may be the chief cause of its unlikeness to volcanoes of more ordinary form. The snow reservoirs near the summits suggest the same conclusion.

WADIS OF TRIPOLI.

Further notes on the Tripoli hill range, by H. S. Cowper (London Geogr. Journ., IX., 1897, 620–638), contain, among other items, a number of illustrations and brief descriptions of the wadis that descend toward the Mediterranean coast. They dissect the hill country, emerging by gate-

like outlets in its north-facing escarpment, and then traverse a sloping plain that descends to a barren sandy strip before reaching the sea. They form the natural paths of travel by which the hill tribesmen always go to and from the coast.

W. M. DAVIS.

HARVARD UNIVERSITY.

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## *CURRENT NOTES ON ANTHROPOLOGY.*

### STUDIES IN MAYAN HIEROGLYPHS.

IT is as agreeable as it is rare to find a sane student of the Mayan hieroglyphs. For that reason among others it is pleasurable to mention several articles which have appeared lately from the pen of Mr. Lewis W. Gunckel, of Dayton, Ohio.

Two of these are in the *American Antiquarian* for the present year. They are entitled, 'The numeral signs in the Palenque tablets,' and 'An Analysis of the day-signs in the Palenquen inscriptions.' A third is in the *American Anthropologist* for May on, 'The direction in which Mayan inscriptions should be read.' All of these indicate thorough investigation and calm judgment, as well as a good acquaintance with what his predecessors in the field have accomplished. The method pursued is scientific and the presentation of the results temperate.

Of course, some of such results may have to be modified by future research, and they may not be good in all cases, that is, in other parts of the field; but the plan which Mr. Gunckel has adopted of approaching these intricate problems is one sure to be productive of additions to our positive knowledge concerning them.

### PRIMITIVE DECORATIVE ART.

FOR the analysis of primitive art-motives no paper has appeared for a long while more instructive than that by Dr. Franz Boas in the Bulletin of the American Museum of Natural History, Vol. IX., entitled 'The decorative art of the Indians of the North Pacific Coast.' The tribes whom he has in view are celebrated for the abundance of their painting and sculpture, their totem poles, colored dishes and carved pipes, and all are somewhat familiar with their strange and perplexing designs. These are analyzed in the article referred to with masterly skill, and the text is furnished with ample and accurate illustrations, which enable the reader to follow the demonstration step by step.

Certain general principles furnish the key to these primitive art-motives. It was the aim of the artist to bring into prominence the most specific feature of the animal he drew, and yet to show as much of the whole of it as he could. As he knew nothing of perspective, he resorted to the most curious devices to accomplish his aim. He represented his subject in sections and distortions, and sometimes by its specific feature reduced to a mere symbol, as a beaver by its incisor teeth only. Many of these devices belong to primitive art generally, and hence this paper will efficiently aid the student in other fields than the Northwest Coast.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

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## *SCIENTIFIC NOTES AND NEWS.*

WE publish elsewhere a full report, by the General Secretary, of the Detroit meeting of the American Association for the Advancement of Science. Although the attendance was small, the scientific programs were in many sections unusually strong and promise well for the future of the Association. A notable meeting on the occasion of the fiftieth anniversary of the Association next year at Boston, with Professor Putnam as President and Mr. Howard as Permanent Secretary, is assured.

WE are glad to be able to publish in this issue the address of the President of the British Association, given on Wednesday of this week. The addresses of the Presidents of the Sections

were of great interest. These were in most cases on general topics, and in accordance with the custom of the Association a special title was not given to most of the addresses and the subjects were withheld until they were delivered. The programs promise the discussion of many interesting topics, American men of science being well represented.

The French journals publish the programs for the meeting of the French Association for the Advancement of Science, held last week at Saint-Étienne. There were fifteen papers presented in mathematics, fifteen in the physical and chemical sciences, seventy-two in the natural sciences and twenty-eight in the economic sciences. Many interesting topics were brought forward, but, contrary to the usual programs of the British Association, there is a noticeable absence of the names of French men of science having an international reputation. The Association appears, however, to be in a flourishing condition as regards number of members and finances, the annual receipts amounting to nearly $20,000.

The British Treasury has appointed a committee "to consider and report upon the desirability of establishing a National Physical Laboratory for the testing and verification of instruments for physical investigation, for the construction and preservation of standards of measurement, and for the systematic determination of physical constants and numerical *data* useful for scientific and industrial purposes, and to report whether the work of such an institution, if established, could be associated with any testing or standardizing work already performed wholly or partly at the public cost." The members of the committee are: Lord Rayleigh (chairman), Sir Courtenay Boyle, Sir Andrew Noble, Sir John Wolfe Barry, W. C. Roberts-Austen, Esq., Robert Chalmers, Esq., A. W. Rücker, Esq., Alexander Siemens, Esq., and T. E. Thorpe, Esq.

The bill regarding the use of the metric system in Great Britain has been passed by the House of Lords.

The American Museum of Natural History, New York, has been presented with two fine collections of butterflies. Mr. William Shaus, formerly of New York, but now resident in London, has given his collection of tropical butterflies, said to contain over 10,000 specimens and valued at $20,000. Dean E. A. Hoffman, of the General Theological Seminary, New York, is the other donor, and his collection is said to be complete with regard to North American species.

The Arnold Aboretum, Harvard University, has received from Miss Abbey A. Bradley, of Hingham, Mass., a gift of $20,000. The money has been given in memory of her father, the late William L. Bradley, the income to be used in scientific investigations on arboriculture.

The British House of Commons has voted £809,992 for the Department of Science and Art and £162,439 for the British Museum.

M. Falguière has now completed his model for the statue of Pasteur. It is expected that the Municipal Council will permit the erection of the statue on the space between the Panthéon and l'Odéon.

Dr. Joseph J. Kinyoun, of the U. S. Marine Hospital Service, has been designated by the Secretary of the Treasury as a delegate to the International Conference on Leprosy, to be held at Berlin during October, and has also been directed to visit the Continental bacteriological laboratories for the information of the Marine Hospital Service.

Mr. T. I. Pockock has been appointed Assistant Geologist in the British Geological Survey. Dr. W. F. Hume and Mr. L. Gorringe have been appointed assistants of the Geological Survey of Egypt, the work of which, as we announced last week, has been greatly enlarged.

The Brooklyn Institute announces that Dr. Fridjof Nansen is one of the lecturers engaged for the coming season.

The Royal College of Physicians, London, has conferred the Moxon gold medal on Sir Samuel Wilks, President of the College, for his work in clinical medicine, and the Baly medal on Professor Schäfer, for his work in physiology.

The Civil Service Commission announce a vacancy in the position of computor in the

office of the Coast and Geodetic Survey, and several vacancies in the position of fish culturist. Details can be obtained by application to the Commission.

PROFESSOR LANGLEY was present at the meeting of the Paris Academy of Sciences on August 2d, and was welcomed by the President and M. Berthelot. Professor Langley gave an account of the results of his experiments with the aërodrome.

LORD KELVIN arrived in New York last Friday on the 'Campania.' He will return to New York on his way home after the meeting of the British Association and a visit to Nova Scotia.

THE second International Bibliographical Conference opened its proceedings, under the presidency of M. le Chevalier Descamps David and M. Lafontaine, at Brussels on August 2d. At the opening session the delegates gave an account of bibliographical progress in their respective countries.

THE conference of South African States on the rinderpest was opened at Pretoria on August 2d, with Mr. Schutte as chairman. Rinderpest is reported to have destroyed the buffalo in North Matabeleland. The natives state that since the disappearance of the buffalo the tsetse fly has been unknown in the fly belt.

THE British Institute of Mechanical Engineers celebrated, beginning on July 29th, the fiftieth anniversary of its foundation. The meeting was at Birmingham, where the Institute was founded and where it had its headquarters until 1877, when it was removed to London. The President, Mr. E. Windsor Richards, gave an account of the history of the Institute, with special reference to the presidents, beginning with George Stevenson. A gift of £3,000 was voted to the retiring Secretary, Mr. Bache, in recognition of his services which have contributed so greatly to the success of the Institute.

THE Third International Congress of Sociology met at the Sorbonne, Paris, during the last week in July, under the presidency of M. Paul de Lilienfeld, Senator of the Russian Empire.

WE learn from the *Revue Scientifique* that M. Louis Adrien Levat, President of the *Ligue Française ornithophile*, having its headquarters in Aix-en-Provençe, is engaged in organizing an international congress for the protection of insectiverous birds. It is proposed to hold the congress in October next and foreign societies are invited to send delegates.

THE Sixteenth Congress of the Sanitary Institute of Great Britain will be held at Leeds from the 14th to the 18th of September, under the presidency of Dr. Robert Farquharson, M. P. An exhibition will be held in connection with the Congress.

THE commissioners for the Exhibition of 1851 have made appointments to Science Research Scholarships for the year 1897, on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years in any university at home or abroad. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result directly in work of scientific importance. This year three scholars have been reappointed for a third term, fourteen have been reappointed for a second term, and nineteen new appointments have been made. The Scholarships Committee consisted of Sir Henry Roscoe, chairman, Lord Rayleigh, Lord Kelvin, Lord Playfair, the late Mr. Mundella, Dr. William Garnett and Sir J. Norman Lockyer.

THE John Lucas Walker studentship of pathology at Cambridge is vacant and candidates are invited to send applications to Dr. A. A. Kanthack, Cambridge, not later than October 15th. The scholarship is for original research in pathology and is of the annual value of £250, tenable for three years. It is open to women as well as men.

IT is well known that before the success of the Atlantic Cable a company was formed to establish communication with Europe by an overland telegraph line via Alaska and Siberia,

and surveys in Alaska were made for this purpose. Mr. R. A. Fessenden contributes an article to the *Electrical World* raising the question of reviving the plan for such a telegraph line. He maintains that commerce with the East would justify the cost and that high speed systems of telegraphy would give it a great advantage over sub-marine cables even in communication between America and Europe.

The Appalachian Mountain Club of Boston, has arranged an excursion to the Isle of Shoals, N. H., leaving Boston by special car at 9:40 a. m. on September 4th, returning on September 7th.

It is reported that the biological expedition of Columbia University returning from Alaska lost its specimens and instruments in the wreck of the steamship *Mexico*. It was also reported that the anthropological expedition of the Field Columbia Museum had lost the extensive collections secured in Alaska, but this appears to be incorrect.

It is stated in the *Scientific American* that Mr. H. P. Flower, Mayor of New Orleans, has just returned from Paris, where he went in order to study the Bertillon system for the identification of criminals. The system will be adopted in New Orleans, and will be taught to the police captains by Mr. Flower.

We recorded last spring the sale of a great auk's egg for £294. Though the subject has, perhaps, no greater scientific interest than that of the sale of a rare postage stamp, it may be noticed that another of the eggs, slightly cracked, has been sold in London for £168. The purchaser, Mr. Middlebrook, has now three specimens in his collection.

The recent French motor-car race from Paris to Dieppe showed an advance, in that the carriages were not entered by the makers, but by the owners. Fifty-nine carriages started, the winner traversing the distance of ninety-three and three-fourths miles in scarcely more than four hours. There was only one steam-carriage and none with electrical motor, oil being used in fifty-eight of the fifty-nine carriages.

The issue of the *Scientific American* for August 7th very properly criticises another journal for publishing a story about an English lady who lost her diamond ring in the dough of a cake and found it by means of X-rays, remarking that "this very improbable story doubtless originated in the brain of some reporter." It happens, however, that a few pages further on in the same issue the *Scientific American* publishes a long article translated from a French illustrated journal on the X-rays in the custom house. The article contains elaborate illustrations of the radioscopic examination of a valise, of the detection of a smuggler, etc. The facts of the matter are that M. Pallin, the Director of Customs, has considered the possibility of using X-rays in certain special cases, but the detailed accounts and the alleged photographs of the article evidently 'originated in the brain of some reporter.'

Jacob North & Company, Lincoln, Neb., announce that they have in press the Phytogeography of Nebraska, by Dr. Roscoe Pound, Director of the Biological Survey of Nebraska, and Mr. F. E. Clements, assistant instructor in botany in the University of Nebraska. It is the first volume of a series intended to present in a number of volumes the results of the investigation of the floral covering of Nebraska, which has been in progress for the past five years in the Botanical Survey of that State. The volume deals primarily with phytogeographical problems in Nebraska, but gives a general treatment of the phytogeographical principles relating to distributional statistics, regional limitation, vegetation forms, habitat groups, plant formations, etc.

A circular has been issued announcing a journal entitled *Intermédiare des biologistes*, intended to be an international organ for zoology, botany, physiology and psychology. The journal will be edited by M. Alfred Binet, the well-known French psychologist, with the help of two of his psychological assistants, MM. Victor Henri and N. Vaschide, and will be published on the 5th and 20th of each month by Schleicher Frères, Paris. The date when the publication will begin and the price are not given. The journal proposes to cover six departments: A bulletin of notes and news, questions and answers, abstracts, preliminary notices, one short original article and new apparatus.

THE *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, edited by Professors H. Ebbinghaus and Arthur König, and published since its foundation by Leopold Voss, Hamburg, will hereafter be published by J. A. Barth, Leipzig. The same publisher will also assume the publication of the continuation of Professor J. von Kries' 'Abhandlungen zur Physiologie der Gesichtsempfindungen' and of Helmholtz's 'Vorlesungen über Theoretische Physik,' of which latter work they hope to publish two further volumes during the coming year.

WE are glad to note the establishment of a monthly scientific journal at DeLand, Fla., entitled *Studies from Nature*. Although the subscription price is only 50 cents per annum, we fear that the publishers will not succeed in securing the 50,000 subscribers that they expect. Such local journals devoted to the natural sciences as they appeal to amateurs are healthful signs of an interest in what the conductors of this journal call 'The Wonders and Beauties of Nature.'

DR. W. FLINDERS PETRIE, the Egyptologist, has sent, according to the daily papers, to Dr. Breasod, of the University of Chicago, a valuable collection of relics excavated along the Nile. Among these are statues of Nen Khefea, a wealthy nobleman, and his wife, which are said to be nearly 5,000 years old. They are of limestone and are remarkably well preserved. They will go to the Haskell Oriental Museum of the University.

WE learn from *Natural Science* that the Zoological Museum of the Royal Academy of Science, St. Petersburg, has acquired thirty-three specimens of fossil bones and numerous remains of Post-Tertiary mammals collected by J. Savenkov at Krasnoyarsk. Among them are some bones and a piece of skin of *Rhinoceros tichorhinus*, which were taken from a well-preserved specimen of a rhinoceros, covered with skin, found 60 versts east of Kasatschje, on the bank of the Charaula, a left tributary of the Tomskaia. Dr. G. Stefanescu, the eminent Roumanian geologist, has discovered two portions of the mandible of a species of *Camelus* in an undoubted Quaternary gravel, six meters below the surface on the river bank of the Olt at Milcovul-de-jos, near Slatina, Roumania. He regards the species to which they belong as new, and names it *Camelus alutensis*.

WE learn from *Nature* that at a meeting of the Essex Field Club, on July 21st, a discussion was held for the consideration of practical methods for the protection of our native fauna and flora from the destruction and actual extermination which now threaten many interesting species. Mr. C. G. Barrett (Hon. Secretary to the Committee of the Entomological Society for the Protection of Insects in danger of extermination) opened the subject by a short address on 'Insect protection; its necessity, means and objects.' Mr. J. E. Harting spoke with respect to birds and mammals; Professor Boulger referred to the wholesale collecting which was exterminating many rare plants; and Professor Meldola urged that children should be taught to respect the sacredness of life. The following resolution of Professor Boulger's was adopted unanimously, and the Club resolved to assist the scheme of the Entomological Society in every possible way: "That in view of the danger of extermination threatening many beautiful, rare and interesting plants, all lovers of nature should do their best to avoid this danger: (*a*) By abstaining from wholesale collecting, collecting for merely individual private collections, needless rooting-up of specimens, attempting to cultivate wild specimens of refractory species, and purchasing such wild specimens from itinerant or other dealers; (*b*) by endeavoring to persuade others, especially school children, cottage gardeners, and dwellers in large towns, to a similar abstention."

A REUTER telegram from Stockholm says that in a letter to the *Aftonblad*, Dr. Nils Ekholm, who accompanied Herr Andrée to Spitzbergen last year with the intention of taking part in his aërial voyage, offers some remarks on the prospect of the expedition based on the full details now received of Herr Andrée's ascent. Herr Ekholm declined to go this year because he considered that the impermeability of the balloon was unsatisfactory. In his letter he points out that from the day the balloon was fully inflated it lost 51 cubic meters of gas every 24 hours, representing a diminution in

carrying capacity of 56 kilogrammes per day. This, he says, shows that the imperviousness of the balloon had not been essentially increased since last year. Besides this daily escape, various circumstances led to a certain loss of gas in the ascent itself, necessitating a corresponding sacrifice of ballast. After making allowance for these losses of gas, and taking into consideration the fact that in the ascent part of the drag-ropes were lost and that the balloon at once rose to a height of 15,000 ft. to 25,000 ft., which was more than had been reckoned upon, Dr. Ekholm comes to the following conclusions: The longest time for which the balloon would remain in the air would be from 22 to 24 days, and less if mountains exceeding the height attained at the start had to be crossed. As the duration of the projected voyage may be estimated in ordinary conditions as regards wind at 24 days, remarkable good fortune would be necessary for success.

Lieutenants Vannutelli and Caterni, the surviving officers of the Bottego expedition, have sent in a report to the Italian Geographical Society, which is summarized in a dispatch to the London *Times*. The expedition set out on February 2, 1895, from Sancurar, and after touching Vollamo visited Pogadesen (?), and arrived on June 1, 1896, at Omo. In consequence of continuous fighting with the warlike tribes inhabiting these regions, the members of the expedition were obliged to spend the months of July and August, 1896, on the shores of Lake Rudolf. At this point Dr. Sacchi left the expedition, taking with him some valuable mineralogical and zoological collections and proceeded to Lugh. The main expedition proceeded up to the Ethiopian plateau, stopping at Sajo, whence a letter was forwarded to the Galla chief Degiasmac. In consequence of the friendly assurances given by the latter, the expedition continued its forward march, arriving on March 16th of the present year in the neighborhood of Gabo. The chief, notwithstanding his friendly assurances, behaved treacherously and caused the party to be surrounded, so that they had no course left but to attempt to cut their way out. Of the 86 members of the expedition, 66, including its leader, were killed, the survivors being taken prisoners and having many hardships to endure. On June 6th last the captives were sent by order of the Emperor Menelik to Shoa, where they arrived on June 22d and were handed over to Major Nerazzini. The documents belonging to the expedition were saved, only the collections intrusted to Dr. Sacchi having been lost. It is thought probable that the latter was killed.

The British Society of Inspectors of Weights and Measures recently held its annual general meeting in London. The total membership of the Society is now upwards of three hundred, and sixty cities and towns were represented at the meeting. Sir Henry Roscoe, the Vice-President, made an address on the subject of the metric system of weights and measures. He reminded the members that he was the Chairman of the Select Committee of the House of Commons, appointed two sessions ago, to report on the question of how far it was desirable to alter our system of weights and measures and adopt the metric system, which, he said, was almost universal throughout civilized, and to some extent uncivilized countries. He joined with the members of the Society in the hope that the bill would soon pass into law. It did not do all that they had hoped for, but they must, he thought, accept it as an installment. Sir John Hutton reported that of one and three-quarter million scales examined in London, one-third had proved defective. The members of the Society visited the Victorian Exhibition of the Crystal Palace, where a Section of Weights and Measures had been organized by the Society, and subsequently went to Paris to view the standards and appliances of the French government at the Bureau central.

The Berlin Town Council has decided to appoint a municipal 'hydrologist' for the hygienic supervision of the water supply of the city.

Signor Cesaresco writes to the London *Times* asking for the suppression of the export of quails and small birds from Italy to England. It is said that millions are sent to England from Egypt and from the south of Italy, part of which are caught in defiance of such protective laws as exist, while the rest are netted in the spring and autumn and are kept in more or less

misery till the time comes for their despatch to meet the requirements of the London season, which coincides with the natural nesting time. The French government for some years prohibited the transit of quails through France in the close season, but as this simply led to their being sent through Germany and Belgium the prohibition has been removed, notwithstanding the protests of the Union des Sociétés des Chasses. Millions of small birds called 'larks,' though they include every variety, and especially robbins, killed largely during the breeding season, are also annually exported to England, and it is feared that they will be entirely exterminated in Italy.

## *UNIVERSITY AND EDUCATIONAL NEWS.*

A LARGE majority of the professors of Brown University have signed an open letter addressing to the corporation a protest against attempting to curtail the freedom of speech of the President. The letter gives a straightforward expression to the views which university professors should unite in maintaining and removes from Brown University the stigma put by the corporation in claiming that they can control the freedom of speech of its faculty. President Andrews, however, in accepting the presidency of a magazine 'university' confuses the friends of academic freedom.

THE London University Commission bill has been postponed by the government until next year.

IT is reported in the daily papers that Mr. Washington Corrington, of Peoria, Ill., now eighty-five years old, has appointed trustees to have control of his property, to be used after his death to found a university at Peoria. His property is estimated at over $1,000,000.

THE Bradley Polytechnic Institute, of Peoria, will be dedicated on October 8th, the principal address being made by the Secretary of the Treasury, Hon. Lyman J. Gage.

THE trustees of the University of Illinois have decided to admit women to the College of Physicians, Chicago.

AT a recent meeting of the Council of the University of Paris it was resolved that, as soon as financial resources permitted, the following courses should be added: Experimental physiology, objective psychology and astronomical physics, and additional courses in paleontology and histology.

IT is intended that the name of Croom Robertson, late Grote professor in University College, London, to whom psychology in England is greatly indebted, shall be connected in some way with the new psychological laboratory established at University College. The principal contributors to the fund are Mr. Haldane, Q. C., Mr. A. J. Balfour, Professor H. Sidgwick, Mr. F. Galton, Dr. Savage, Sir John Lubbock and Mr. Shadworth Hodgson.

THE London *Times* reports that at Dewsbury, after the funeral of Dr. Hinchliffe, it was announced that the deceased, after providing for his housekeeper and servants, had bequeathed property and shares, with about £50,000, toward higher education, but the purposes of the bequest are not stated.

DR. H. V. NEAL, Harvard University, has been elected professor of biology at Knox College, Galesburg, Ill.

M. IZOULET has been appointed to the newly established professorship of social philosophy in the Collège de France.

MR. W. W. WATTS, Assistant Geologist at the British Geological Survey, has been appointed assistant professor of geology at Mason College, Birmingham.

DR. HERMANN THOMES, docent in pharmaceutical chemistry in the University of Berlin, has been promoted to a professorship. Professor George Ruge, of Amsterdam, has been appointed professor of anatomy and director of the Anatomical Institute at Zurich. Dr. Ossan, associate professor of mineralogy at Heidelberg, has been called to a chair in the School of Chemistry at Mühlhausen.

## *DISCUSSION AND CORRESPONDENCE.*

### THE ANTECEDENT COLORADO.

TO THE EDITOR OF SCIENCE: In addition to the doubts brought forward by Davis (SCIENCE,

April 23, 1897) and Emmons (SCIENCE, July 2d), as to the antecedent origin of the Green river in its passage through the Uinta mountains, I would suggest an independent and confirmatory argument for the consequent origin of the Green-Colorado in its passage across the plateaus of the Grand Canyon region, where it has been regarded as antecedent by Powell and Dutton. My argument is based on the curvature of the river and especially on its meanders. The meanders are surprising in themselves from the steepness of the river and their deep incision; yet more surprising is the location of strong meander reaches just up stream from structural displacements. It is the latter relation that I wish to point out.

In general, a river meanders when its declivity is low. The Mississippi below Memphis falls less than five inches to the mile and has a typical meandering course (See Table of Meanders). Yet the Colorado, falling more than seven feet per mile in the Canyon region, has stretches of even greater sinuosity and the distribution of these winding reaches suggests that the river is not antecedent, but dependent on the dislocations for its path.

The following table shows the rate of meander for measured stretches of the river, the rate being expressed in miles of actual stream to 100 miles along a mean course traced evenly through the meanders, without departing more than a mile from the water at any point. In the first column is the name given by Powell to the stretches of river, in the second the miles of mean course, in the third the actual course, while the fourth contains the rate of meander:

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Desolation and Gray Canyons— | | | |
| Uinta R. to Book Cliffs, . . . . | 76 | 113 | 149 |
| Gunnison's Valley—to San Rafael R | 30 | 35 | 117 |
| Labyrinth Canyon—to Grand R . . | 51 | 93 | 182 |
| Cataract Canyon — to N 37°37′, W 110°38′ . . . . . | 77 | 81 | 105 |
| Glen Canyon and above—to Paria R | 88 | 139 | 158 |
| Marble and Grand Canyons — to Grand Wash . . . . . | 259½ | 280 | 108 |
| Thence to California boundary. . . | 139 | 145 | 104 |
| Mississippi — Memphis to Baton Rouge . . . . . | | | 155 |

The 139 miles of strong meander above the Paria River bring the Colorado down to the East Kaibab monocline, where the course turns to the south to avoid the uplifted Kaibab plateau, just as the Green turns east on reaching the Uintas. This is best seen on the United States Relief Map, where the darker color is within the river's elbow at the Uinta and against the Kaibab.

At the monocline the river is deviated. In Glen Canyon above the monocline the meandering is greater than the Mississippi's. Below the meandering is reduced to a minimum.

The conclusion is irresistible that the Kaibab uplift introduced a local baselevel (Powell's phrase) that compelled the river to meander on a flat open course until the obstacle gave passage to one side.

Less than a hundred miles further north in the Cataract Canyon, near the junction of the Green and Grand, the river's course is straight (meander rate, 105). Next above this is the very sinuous Labyrinth Canyon (rate, 182). The geological map here shows a dome with Permian and Carboniferous brought to the surface, a part probably of the San Rafael disturbance. Through the dome the course is in the straight Cataract Canyon; the Labyrinth Canyon is the northern approach.

Is the analogy here to the Kaibab and Glen Canyon casual?

Gunnison's valley is instructive. It has little meander and no uplift. Dutton reports it to be the only open valley on the river besides Brown's Park, and attributes this character to the softness of strata that weather back too rapidly to stand in canyon walls. In this case surface meanders would be lost here, as the the valley would straighten as it widened under erosion.

To the north the meandering is again great. At the time the river took to meandering it may well have had such a course from the Uintas to the dome, preserved to us where the rocks were hard and the river now runs in canyons, but lost in the softer strata. North of the Uintas I have no map, but this stretch of Gunnison's suggests that meanders would not be preserved in the soft rocks of the Bad Lands.

In this connection I would call attention to a striking feature of the Grand Canyon faults, as described by Dutton in his monograph. He says the ends of the down-thrown strata are commonly turned *down* in this region, the beds on the other side coming undisturbed to the fault. This is specifically described for the West Kaibab and Hurricane faults, both with up-throw to east.

The phenomenon of the down-turned edges is puzzling, but it might result from the following history. All the steps assumed to follow in succession are found in the region to-day:

1. Western beds flexed up, giving a western high level passing through a monocline to an eastern low level.

2. Flexure becomes a fault at the foot (east end) of the monocline, giving western high level passing down a monocline to an east-facing fault cliff, below which lie the horizontal beds of the undisturbed side.

3. Reversal of fault, giving upthrow on east and the structure existing to-day—low level on west passing to a west-facing fault cliff by a down-turn (monocline perhaps partly obliterated by friction during the reversal).

In confirmation is the fact that both faults are greatest in the north and steadily diminish southward, the Hurricane having at the river less than a sixth of its northern value, while the West Kaibab disappears just where it crosses the chasm. Dutton thinks it reappears to the south of the canyon, but *reversed*, giving an east-facing cliff. So if the observation of Dutton is good, reversal of fault has occurred in one case and there is a suggestion of it in the other. Now the significance of this fault history is that the river seems conscious of something of the sort. It turns south on the second V of the Grand Canyon at the Hurricane fault, as if to avoid the early western uplift, now recorded only in the down-turned strata-ends; while at the Kaibal the reversal-point has been selected by the river to return northward from the deviation about the uplift here. The peculiar grouping of meanders is readily seen on the map, as also the relation of bends in the river to the displacements at the Uinta, junction of Grand and Green, Kaibab (East and West), and Hurricane.

In explaining these latter events as represented in effect on the present river, I have founded my suggestion on that simple and diagrammatic character that Powell and Dutton have described in this region.

Are not these additional grounds for questioning the Colorado's antecedence?

MARK S. W. JEFFERSON.

GILMANTON, N. H.

## AMPHIBIA OR BATRACHIA.

TO THE EDITOR OF SCIENCE: As a teacher of zoology, but without claim to expert authority upon taxonomic points, I read the article of Dr. Baur under the above title (SCIENCE, July 30, 1897, 170–174), with the hope and expectation of being able to decide which name to employ hereafter. I regret to confess myself still unconvinced. Dr. Baur shows that the French word *Batraciens* was applied to the frogs, toads and salamanders by Brogniart in 1799, and that the Latin forms *Batrachii* and *Batrachia* were not introduced until 1804 and 1807, by Latreille and Gravenhorst respectively. But does not Dr. Baur lay undue stress upon the distinction between the French and the Latin form. *Batraciens* is not (like *crapaud*, etc.) a vernacular word; it is the French form, or Galloparonym, of the Latin *Batrachia*, and the employment of the former would seem to constructively sanction the use of the latter. In anatomy the employment of either of the national forms, *hippocamp*, *Hippokamp*, *hippocampe*, or *hippocampo*, would be tantamount to the introduction of the international form, *hippocampus*. The principle involved in both cases has been formulated by me in two passages in my 'Neural Terms, International and National (*Jour. Comp. Neurology*, VI., 274, 329), as follows: "The introduction of any derivative, oblique case, or national paronym, practically renders the introducer responsible for the actual or potential Latin antecedent of such words, in accordance with the usual rules of derivation and paronymy." I trust the discussion may continue until all doubts are removed. The case is the more urgent in view of the confusion of students in finding not merely that *Amphibia* and *Batrachia* are synonyms for the entire class,

but also that in Huxley's writings the latter is applied to an ordinal subdivision of the former.

BURT G. WILDER.

## SCIENTIFIC LITERATURE.

*Report on the Valley Regions of Alabama.* By HENRY MCCALLEY, Assistant State Geologist. Part I., on the Tennessee Valley Region, pp. 436. Part II., on the Coosa Valley Regions, pp. 862. Geological Survey of Alabama, Montgomery, 1896–97.

The aim of this report is to give a complete account of the geology and mineral resources of that part of Alabama which is occupied by known Paleozoic formations. This includes approximately the northern third of the State, with an area of about 18,000 square miles. It is limited on the southeast by the metamorphic series of undetermined age and on the southwest by the unconformable post-Paleozoic formations. The term 'valley regions' in the title is somewhat misleading, since all the mountains of Alabama, such as they are, are included in the region described and are as fully treated as the adjacent valleys. Except to one already familiar with the topographic features of the State, the title conveys no idea of location whatever.

The region outlined above is about equally divided between the Tennessee and Coosa drainage basins, and this division is a natural one from geologic and economic points of view. It is, therefore, taken as the basis for subdividing the report into two parts which treat respectively of the Tennessee and Coosa Valley regions. Each part is again subdivided into two sections. In the first is given a general account of the topography, geology and mineral resources, and in the second each county is described in detail. This method of treatment is, perhaps, necessary where the county is the all-important unit in the political and social organization, but its defects are serious as seen in the present case. It involves endless repetition and distributes through a volume details which should be in a compact body. Thus there are 275 more or less extended but entirely distinct references to the limonite deposits, containing sufficient observations for an exhaustive monograph on the subject if brought together and properly arranged. Yet one seeks in vain for any systematic classification of the deposits or a statement of their essential characteristics.

In reading the report one is continually hampered by the lack of maps. It is true the State geological map, published in 1894, is referred to, but its scale is entirely too small for representing details of structure, and in numerous respects it does not correspond with the statements in the report. The crudest sort of sketch maps would be of the greatest assistance to an understanding of the complicated structural relations found in parts of this region. In fact, no amount of verbal description, even from a master of English, can supply their place, and the present case is hopeless for reasons which the following quoted sentence will readily suggest: "The northeast end of the belt, just to the northwest of the Terrapin or Ladiga Mountains, or the portion of that belt within this county, is a portion of the counterpart of the belt last described, or is a portion of the southeast rim of the badly faulted, broad, broken, unsymmetrical synclinal of which the belt last described is the major part of the northwest rim." The reader cannot rid himself of the suspicion that among other reasons for the absence of maps and diagrams is the lack, on the author's part, of a sufficiently clear conception of the structure for their preparation.

In the descriptions of topographic features the principles of modern geography or physiography are entirely ignored. Hence there is a vagueness and uncertainty about the descriptions which might have been excusable twenty years ago, but for which no excuse can be found at the present time. It borders on the absurd to speak of 'high rugged mountains with lofty peaks' in Alabama, where the greatest relief is barely 2,000 feet above the sea-level.

By far the most valuable portion of the report is found in the detailed county descriptions, especially those of mineral deposits. Here is a vast mass of facts, poorly digested and arranged, it is true, but given in such a way that they will be of great service in the economic development of the region. All locations are given by land numbers, so that, while they convey little meaning to the general reader, they are in the best possible form for use by the prospector upon the ground.

C. W. HAYES.